THE SHERWIN-WILLIAMS COMPANY
Environmental, Health & Regulatory Services
101 Prospect Avenue NW
Cleveland, Ohio 44115-1075
Facsimile: (216) 566-2730

April 29, 2009

Mr. Ray Klimcsak
U.S. Environmental Protection Agency – Region 2
290 Broadway 19th Floor
New York, New York 10007-1866

RE: Response to EPA Comment Letter Dated August 14, 2007 regarding review of November 30, 2006 *Response to EPA Letter Dated August 7, 2006 - Appendix A (Dump Site Groundwater Investigation)*

The Sherwin-Williams Company Sites - RI/FS Activities
Gibbsboro, New Jersey
Administrative Order Index No. II CERCLA-02-99-2035

Dear Mr. Klimcsak:

The Sherwin-Williams Company (Sherwin-Williams) has prepared the attached Technical Memo in response to the U.S. Environmental Protection Agency (EPA) Comment Letter dated August 14, 2007 regarding review of the November 30, 2006 *Response to EPA Letter Dated August 7, 2006 - Appendix A (Dump Site Groundwater Investigation)* submitted by Sherwin-Williams pursuant to Administrative Order Index No. II CERCLA-02-99-2035 for Remedial Investigation /Feasibility Study activities.

Sherwin-Williams received detailed comments on Appendix A from the EPA in a letter dated August 14, 2007 and is providing a point-by-point response to the detailed comments contained within that letter. In order to ease your review we have included the text from that letter, which is depicted in *italics.* Sherwin-Williams' response immediately follows each EPA comment in **bold**. A copy of the August 14, 2007 letter is included as an attachment. The comments have been addressed and incorporated into the revised Appendix A that has been included with this submission.

Background Information

The following documents have been submitted and reviewed during the course of the field investigation conducted at the Dump Site:

- *Evaluation of Strategic Sampling Results – Route 561 Dump Site* dated May 23, 2006 (from Sherwin-Williams)

- EPA Comment Letter dated August 7, 2006 on *Evaluation of Strategic Sampling Results – Route 561 Dump Site* (May 23, 2006)

- Response to EPA Comment Letter of August 7, 2006; dated November 30, 2006 (from Sherwin-Williams)

- EPA Comment Letter dated August 14, 2007 on *Response to EPA Letter dated August 7, 2006 - Appendix A (Dump Site Groundwater Investigation* (November 30, 2006)

On April 3, 2008, a conference call regarding the groundwater issues was held between EPA and Sherwin-Williams. The call provided additional direction and clarification of the August 14, 2007 EPA Comment Letter regarding Appendix A (Groundwater Investigation) of the *Response to EPA Letter Dated August 7, 2006 – Sherwin-Williams Gibbsboro Sites - Route 561 Dump Site* (dated November 30, 2006).

On August 29, 2008 revised groundwater contour maps were forwarded to EPA for review and concurrence. On December 18, 2008, during a joint EPA/Sherwin-Williams project meeting, EPA approved the revised contour maps and based upon those maps proposed that 11 new wells (five shallow and six deep) be installed at the Dump Site.

These 11 wells are comprised of four well couplets, two deep wells and one shallow well. The four well couplets are proposed at three off-site locations in addition to one location within the Dump Site. The two deep wells are intended to be co-located at existing shallow well locations (DMMW0001 and 0003) to form couplets. There is one shallow well proposed within the fenced area near the northeastern fence line adjacent to Clement Lake. These locations are presented on the attached Figure 1.

On March 25, 2009, Ray Klimcsak (EPA) along with Patrick Austin and Arthur Fischer (both Weston Solutions, Inc. [Weston®]) inspected the proposed locations that Weston and the drilling subcontractor (ECDI) marked out the previous week. Due to accessibility issues, there were three locations identified that would require the proposed monitor well locations to be shifted. They are as follows:

- Due to the proximity of underground and overhead utilities, it is suggested that the proposed well cluster on Marlton Avenue be shifted approximately 30 feet from the south side of the street to the north side of the street.

- Due to the proximity of a large tree, the proposed well cluster next to the Medical Arts Building (across Route 561 from the Dump Site) will need to be shifted approximately 10 to 20 feet in a northeasterly direction towards Route 561.

- Due to its location in an inaccessible area of the wetlands (soft, wet soils), it is suggested that the proposed well cluster in the middle of the site (near the base of the slope where the culvert from the Wawa parking lot runs) be shifted upslope approximately 50 feet to a more accessible, stable area.

As a result of this site walk, EPA concurred with the re-location of the well clusters located on Marlton Avenue and next to the Medical Arts Building. However, in lieu of the monitoring well cluster in the middle of the site (near the intermittent stream), EPA is requesting that three or four pore water samples be collected along the intermittent stream. These revised monitor well and pore water locations are presented on the attached Figure 2.

Comments and Responses

1) *SWC response letter, page 6 - SWC states that, based on the information presented in Appendix A, their previous conceptual model is valid and "that the well locations originally proposed are appropriate for the next phase of the groundwater investigation, and is requesting EPA concurrence with these locations." Based upon the following discussion, EPA does not concur with this statement and still contends that flow directions and velocities at the Route 561 Dump Site are not demonstrated.*

Sherwin-Williams had originally presented a contour map depicting generalized groundwater elevations and flow directions for the Dump Site. Based on EPA comments, Sherwin-Williams subsequently revised the contour maps to be more specific and to honor all topographic contours and stream elevations.

The revised groundwater contour maps were submitted to EPA for review on August 29, 2008, and were subsequently approved on December 18, 2008. All subsequent flow directions, horizontal hydraulic gradient and seepage velocity calculations are based upon these revised groundwater contour maps.

The revised groundwater contour maps are provided as Figures A-1 through A-3, inclusive, in the revised Appendix A that has been included with this submission.

2) *Appendix A, Page A-3 - The text states that the groundwater flow is "reflective of the topography" and that "Surface water elevation data....were used as control elevation points to aid in the groundwater contour design in the vicinity of creeks and water bodies." Examination of Figures A-1, A-2, and A-3 prove that this is incorrect. Much of the Route 561 Dump Site area depicts groundwater contours which are topographically higher than surface elevations. This error has caused SWC to make incorrect assessments of groundwater flow directions and flow velocities. Instead of a tabular flow pattern that is directed to the southwest, the flow patterns are going to be quite variable and highly affected by surface topography. This error must be corrected before additional well locations can be selected.*

Sherwin-Williams had originally presented a contour map depicting generalized groundwater elevations and flow directions for the Dump Site. Based on EPA comments, Sherwin-Williams subsequently revised the contour maps to be more specific and to honor all topographic contours and stream elevations.

The revised groundwater contour maps were submitted to EPA for review on August 29, 2008, and were subsequently approved on December 18, 2008.

Revised text and groundwater contour maps (Figures A-1, A-2, and A-3) are provided in the revised Appendix A that has been included with this submission.

3) *Appendix A, page A-4 - The horizontal hydraulic gradients in the text are incorrect. Instead, the gradients are going to be quite variable, depending upon location, and proximity to the surface water.*

Based on EPA comments, Sherwin-Williams subsequently revised the contour maps to be more specific and to honor all topographic contours and stream elevations. Upon evaluating these revised groundwater contour maps, Sherwin-Williams acknowledges that the gradients are going to be quite variable, depending upon location and proximity to the surface water.

A more detailed discussion of the horizontal hydraulic gradients is provided in the revised Appendix A that has been included with this submission.

4) *Appendix A, page A-5 - The lower bound on hydraulic conductivity stated in the text is likely incorrect. Examination of the curve match indicates that there was no sand pack porosity supplied for this analysis. EPA recommends a re-examination of this analysis and re-calculation of the averages.*

Sherwin-Williams has re-run the hydraulic conductivity solutions using sand pack porosity as applicable, and re-calculated the hydraulic conductivity averages.

The revised hydraulic conductivity solutions and averages are summarized in Table 4 in the revised Appendix A that has been included with this submission. Actual revised graphical solutions are provided as Attachment 5 to the revised Appendix A.

5) *Appendix A, page A-5 - The upper bound on hydraulic conductivity results from using the Hvorslev method of analyzing slug test results. This method has been mathematically proven to be valid only in zero-penetration conditions (i.e., the screen does not penetrate the thickness of the aquifer.) Please do not use this method of analysis for these data. Please recalculate the averages with an acceptable method.*

As discussed and agreed upon during the April 3, 2008 conference call, Sherwin-Williams has calculated hydraulic conductivity values utilizing various slug test solutions (Bouwer and Rice, Hvorslev, Dagan, Hyder et al. [KGS] and Springer-Gelhar). An evaluation of the precision of the various solutions for Dump Site wells is discussed in the text of, and included as part of Attachment 5 to the revised Appendix A that has been included with this submission.

Average hydraulic conductivity values were calculated for each individual well and method, and are included as Table 4 in the revised Appendix A that has been included with this submission.

Sherwin-Williams has evaluated the various slug test methodologies referenced above, and based upon that evaluation recommends that the Bouwer and Rice (1976) Method be used for any future site-specific calculations (e.g., seepage velocity) which require an estimated hydraulic conductivity parameter. Depending on the use of calculation, either well-specific arithmetic mean values or site-specific geometric mean values may be applied.

6) *Appendix A, page A-5 and A-6 - The numbers quoted for seepage velocity are incorrect. See comments above for explanation.*

Sherwin-Williams has re-run the hydraulic conductivity solutions as discussed in Response #4 above. In addition, Sherwin-Williams has recalculated horizontal hydraulic gradients based on the revised groundwater contour maps. Sherwin-Williams has re-calculated the seepage velocity values using the revised hydraulic conductivity values and revised horizontal hydraulic gradients.

The revised seepage velocities are included as Table 5 in the revised Appendix A that has been included with this submission.

7) *Table 4 - Please remove the Hvorslev results and recalculate the averages. (Also, fix Slug-in2 for DMMW0001.)*

As discussed and agreed upon during the April 3, 2008 conference call, Sherwin-Williams has calculated hydraulic conductivity values utilizing various slug test solutions (Bouwer and Rice, Hvorslev, Dagan, Hyder et al. [KGS] and Springer-Gelhar).

Well-specific arithmetic mean values for hydraulic conductivity have been estimated using the results of the rising and falling head slug tests calculated for each individual well and each unique slug-test solution (Bouwer and Rice, Hvorslev, Dagan, Hyder et al. [KGS] and Springer-Gelhar). A site-specific geometric mean has also been calculated.

Average hydraulic conductivity values were calculated for each individual method and summarized in Table 4 of the revised Appendix A that has been included with this submission.

Sherwin-Williams has evaluated the various slug test methodologies referenced above, and based upon that evaluation recommends that the Bouwer and Rice (1976) Method be used for any future site-specific calculations (e.g., seepage velocity) which require an estimated hydraulic conductivity parameter. Depending on the use of calculation, either well-specific arithmetic mean values or site-specific geometric mean values may be applied.

8) *Figures 1A, 2A, and 3A -Please re-contour these figures and use surface water elevation data "as control elevation points to aid in the groundwater contour design in the vicinity of creeks and water bodies;" (i.e., check to make sure your groundwater elevation contours are not above the surface topography.)*

Sherwin-Williams had originally presented a contour map depicting generalized groundwater elevations and flow directions for the Dump Site. Based on EPA comments, Sherwin-Williams subsequently revised the contour maps to be more specific and to honor all topographic contours and stream elevations.

The revised groundwater contour maps were submitted to EPA for review on August 29, 2008, and were subsequently approved on December 18, 2008.

Revised text and groundwater contour maps (Figures A-1, A-2, and A-3) are provided in the revised Appendix A that has been included with this submission.

As noted earlier, all of the above comments and revisions have been incorporated into the revised Appendix A that has been included with this submission.

Should you have any questions or comments regarding any of the responses and explanations presented herein, please do not hesitate to contact me at (216) 566-1794 or via e-mail at mlcapichioni@sherwin.com.

Sincerely,

Mary Lou Capichioni

Mary Lou Capichioni
Director Remediation Services

Attachment
cc: J. Josephson, USEPA
G. Anderson, USEPA
M. Pensak, USEPA
J. McPherson, USEPA
C. Howard, USEPA
J. Doyon, NJDEP
H. Martin, ELM
S. Jones, Weston

Ms. Mary Lou Capichioni
Director
Remediation Services
Corporate Environmental Services
The Sherwin-Williams Company
101 Prospect Avenue, N.W.
Cleveland, OH 44115-1075

Re: *Sherwin-Williams Gibbsboro Sites*
Response to EPA Letter Dated August 7, 2006
Sherwin-Williams Gibbsboro Sites, Route 561 Dump Site - Appendix A (November 30, 2006)

Dear Ms. Capichioni:

The U.S. Environmental Protection Agency (EPA) has completed its review of the November 30, 2006 *Response to EPA Letter Dated August 7, 2006 - Appendix A (Dump Site Groundwater Investigation)* submitted by the Sherwin-Williams Company (SWC) pursuant to Administrative Order Index No. II CERCLA-02-99-2035 for Remedial Investigation/Feasibility Study activities and offers the following comments.

1. SWC response letter, page 6 B SWC states that, based on the information presented in Appendix A, their previous conceptual model is valid and Athat the well locations originally proposed are appropriate for the next phase of the groundwater investigation, and is requesting EPA concurrence with these locations.@ Based upon the following discussion, EPA does not concur with this statement and still contends that flow directions and velocities at the Route 561 Dump Site are not demonstrated.

2. Appendix A, Page A-3 B The text states that the groundwater flow is Areflective of the topography@ and that ASurface water elevation data....were used as control elevation points to aid in the groundwater contour design in the vicinity of creeks and water bodies.@ Examination of Figures A-1, A-2, and A-3 prove that this is incorrect. Much of the Route 561 Dump Site area depicts groundwater contours which are topographically higher than surface elevations. This error has caused SWC to make incorrect assessments of groundwater flow directions and flow velocities. Instead of a tabular flow pattern that is directed to the southwest, the flow patterns are going to be quite variable and highly affected by surface topography. This error must be corrected before additional well locations can be selected.

3. Appendix A, page A-4 B The horizontal hydraulic gradients in the text are incorrect. Instead, the gradients are going to be quite variable, depending upon location, and proximity to the surface water.

4. Appendix A, page A-5 B The lower bound on hydraulic conductivity stated in the text is likely incorrect. Examination of the curve match indicates that there was no sand pack porosity supplied for this analysis. EPA recommends a re-examination of this analysis and re-calculation of the averages.

5. Appendix A, page A-5 B The upper bound on hydraulic conductivity results from using the Hvorslev method of analyzing slug test results. This method has been mathematically proven to be valid only in zero-penetration conditions (i.e., the screen does not penetrate the thickness of the aquifer.) Please do not use this method of analysis for these data. Please recalculate the averages with an acceptable method.

6. Appendix A, page A-5 and A-6 B The numbers quoted for seepage velocity are incorrect. See comments above for explanation.

7. Table 4 B Please remove the Hvorslev results and recalculate the averages. (Also, fix Slug-in2 for DMMW0001.)

8. Figures 1A, 2A, and 3A B Please re-contour these figures and use surface water elevation data Aas control elevation points to aid in the groundwater contour design in the vicinity of creeks and water bodies;@ (i.e., check to make sure your groundwater elevation contours are not above the surface topography.)

If you have any questions on this matter, you may contact Mr. Ray Klimcsak, of my staff, at (212) 637-3916, or if you have any legal concerns, Mr. Carl Howard, Esq., at (212) 637-3216.

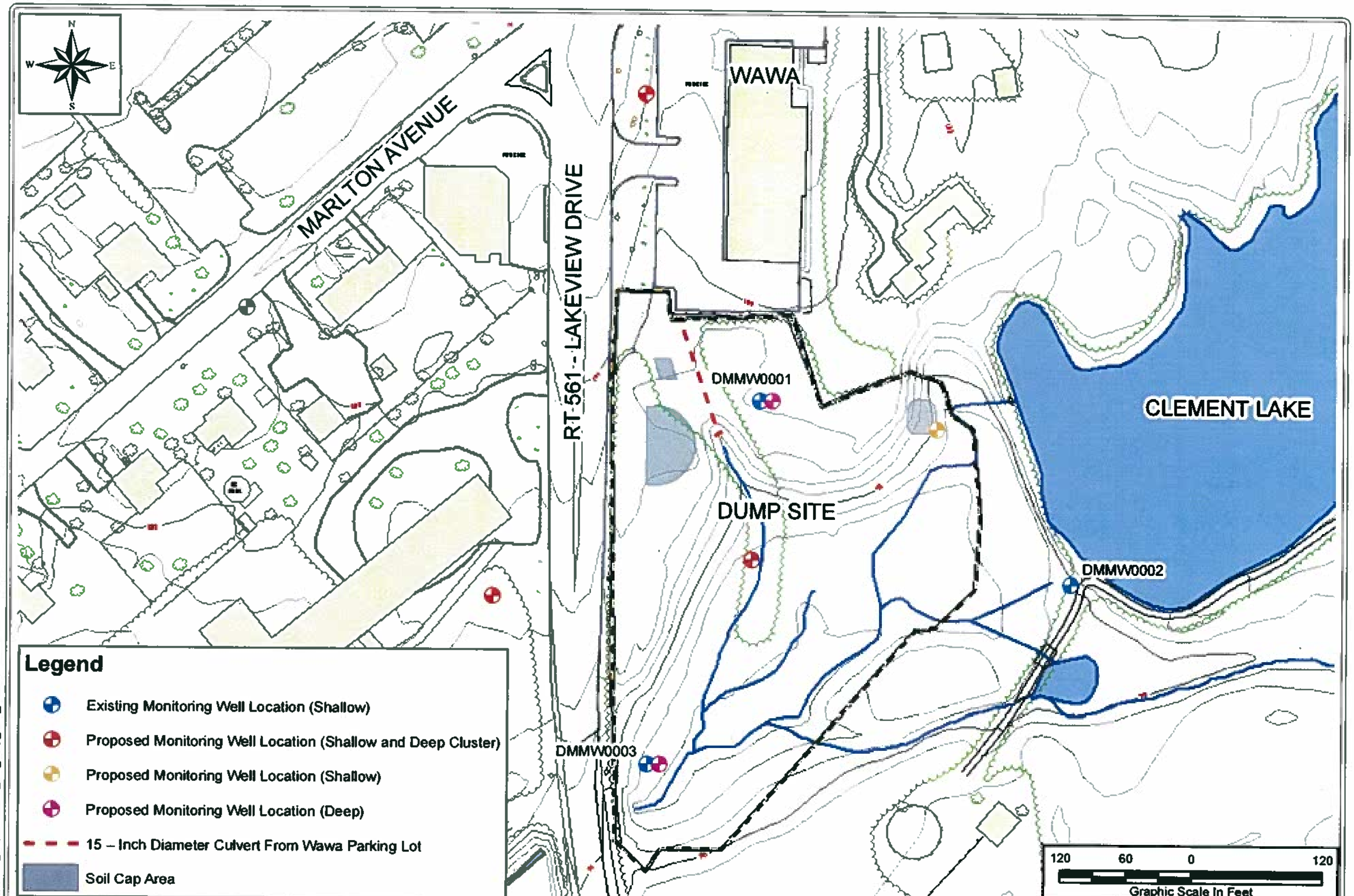
Sincerely yours,

Carole Petersen, Chief
New Jersey Remediation Branch

cc: Sally Jones, Weston
Hank Martin, ELM
John Doyon, NJDEP
Lynn Arabia, TetraTech

Mindy Pensak, EPA
Carl Howard, EPA

Julie McPherson, EPA
Grant Anderson, EPA



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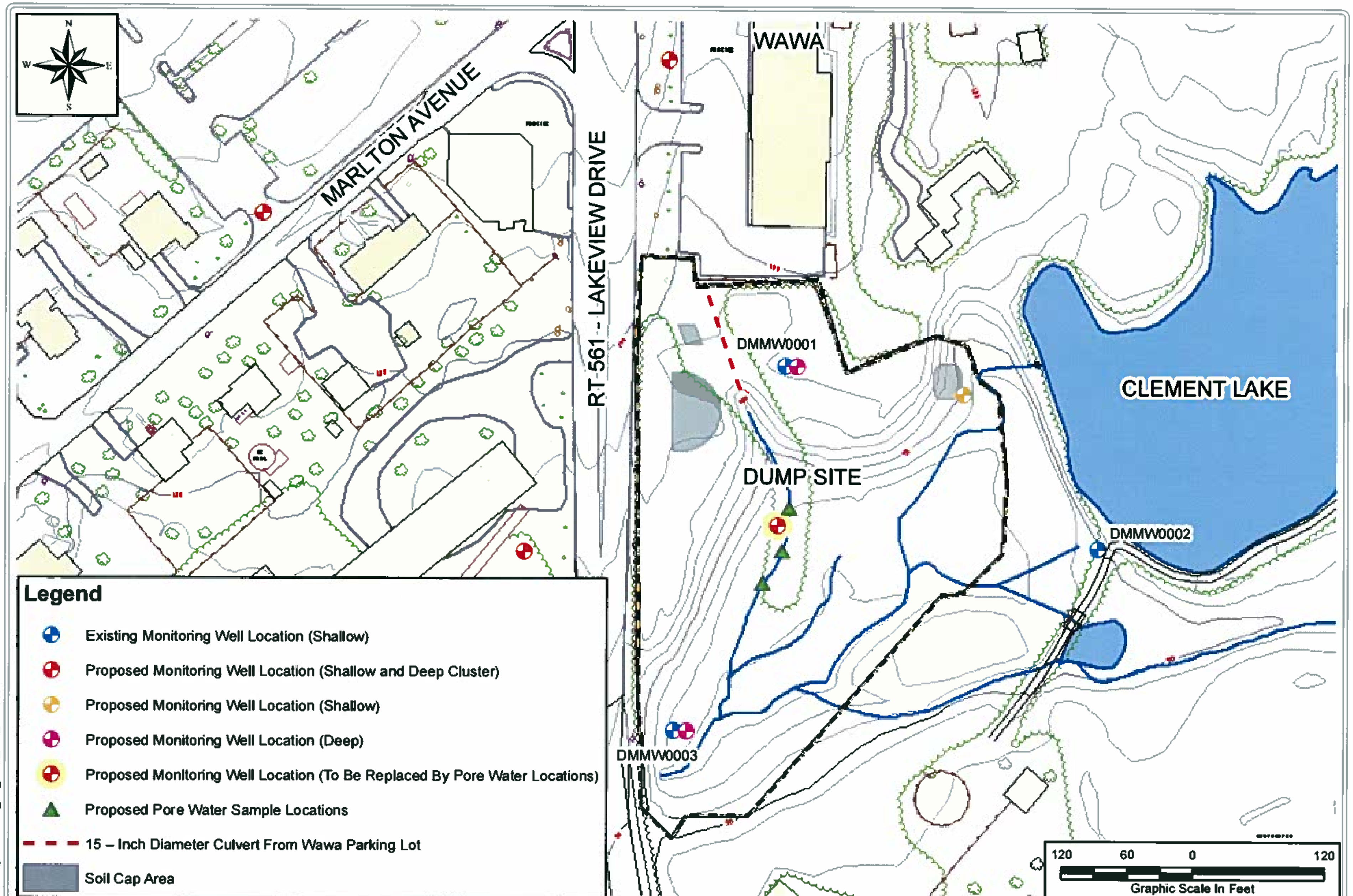
WESTON SOLUTIONS	PROJECT: Sherwin-Williams Gibbsboro Remedial Investigation	TITLE: Dump Site Proposed Monitoring Well Location Map (January 14, 2009 EPA Comment Letter)
DATE: April 2009	CLIENT NAME: The Sherwin-Williams Company	
FIGURE #: 1		



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WESTON SOLUTIONS

DATE: April 2009

FIGURE #: 2

PROJECT: Sherwin-Williams Gibbsboro Remedial Investigation

CLIENT NAME: The Sherwin-Williams Company

TITLE: Dump Site
Revised Proposed Monitoring Well Location Map
With Pore Water Locations
(March 25, 2009 EPA Comment Letter)

APPENDIX A
GROUNDWATER INVESTIGATION

Introduction

Three monitoring wells were installed, developed and sampled during the Remedial Investigation (RI) activities conducted at the Sherwin-Williams Route 561 Dump Site during Summer 2005. Slug tests were also performed at each of the wells in order to develop an estimate of hydraulic conductivity and seepage velocity. The following is a compilation and description of the activities performed.

Drilling and Monitoring Well Installation

Between July 22 and July 26, 2005 three monitoring wells (DMMW0001, DMMW0002 and DMMW0003) were installed at the Dump Site during the Gibbsboro RI activities. The Dump Site is located between Clement Lake and Lakeview Drive (Route 561). The drilling and monitoring well installations were conducted by East Coast Drilling, Inc. (ECDI) of Moorestown, New Jersey. ECDI is a New Jersey licensed driller (New Jersey License No. M1224). All drilling and monitoring well work was performed under supervision of trained and experienced Weston Solutions, Inc. (Weston®) personnel.

All borings were advanced by ECDI with a rubber-tracked model 6610DT Geoprobe® rig capable of hollow-stem auger (HSA) borings. Direct-push technology was used for logging of soil samples from each well location. Drilling was limited to the upper 15 feet below ground surface (bgs). A 5-foot MacroCore® sampler and disposable acetate sleeves were used for collection of all soil samples. All soil samples were inspected and logged by a qualified field geologist and field screened using a photoionization detector (PID). Subsequent to the field activities a soil boring log was created for each boring describing the soil types encountered, visual observations such as staining, and PID readings. No soil samples were collected for laboratory analyses.

Monitoring wells were installed by over-drilling each soil boring location using 8-inch outside diameter (4.25-inch inside diameter) hollow-stem augers. The monitoring wells were constructed of 2-inch-diameter, schedule-40 polyvinyl chloride (PVC) well screens and riser pipes. The well screens were 10 feet in length and had 0.010-inch (10-slot) slot sizes. The well filter pack was constructed with Morie sand #1, and granulated bentonite was used to fill the annular seal above the sand filter pack. The filter packs were placed in the well borehole from approximately 1.0 foot below, or at the bottom of the well screens, up to approximately 1.0 to 2.0 feet above the screen. A finer Morie sand #00 was used as a choke layer between the filter pack and the bentonite seal. All wells were finished above grade using 6-inch diameter protective steel stick-up outer casings. Sloping concrete pads measuring approximately 2 feet by 2 feet and 4-6 inches thick were placed around the protective outer casings to seal and secure the wells above ground. All wells were marked with their respective identifications on steel tags held by steel collars around the well outer casings.

A summary of monitoring well construction details is provided in Table 1 and the complete Soil Boring and Monitoring Well Construction Logs are provided in Attachment 1. Soils encountered in the Dump Site predominantly consist of fine to coarse sand with varying amounts of silt and gravel. Detailed lithologic descriptions are presented in the above-referenced soil boring logs provided in Attachment 1.

Copies of the New Jersey Department of Environmental Protection (NJDEP) Monitoring Well Permit (DWR-133M), Monitoring Well Records, and Monitoring Well Certifications (Form A) are provided in Attachment 2.

All attachments, tables and figures included with this submission are included on the accompanying CD.

Monitoring Well Development

The monitoring wells were developed following installation by using a surge block and small submersible pumps (Whale and/or Typhoon pumps). The pump was initially placed at the bottom of the well screen and manually surged up and down at periodic intervals. A portable turbidity meter (LaMotte Model 2020) was used to monitor water turbidity during well development. The turbidity meter was calibrated in the field prior to well development using turbidity standards of 1 and 1,000 nephelometric turbidity units (NTU). Water was collected directly from the dedicated polyethylene pump discharge tubing at 5-minute intervals for turbidity monitoring. The development water was containerized in 55-gallon drums, labeled, and stored on site for future disposal.

The monitoring wells were developed between 45 minutes to a maximum of 4 hours until the development water became relatively silt-free and clear based on turbidity readings. Final turbidity readings at wells DMMW0001 and DMW0003 were below 10 NTU. Well DMMW0002 was developed on two occasions for a total time of over 4 hours. The final turbidity at DMMW0002 was 55 NTU. Well development data are summarized in Table 2 included on the accompanying CD.

Monitoring Well Survey

The monitoring wells were surveyed by T&M Associates, of Moorestown, New Jersey. T&M Associates is a New Jersey-licensed surveyor (N.J.P.L.S. No. 32106). Well survey data included all horizontal locations, ground surface elevations, top of inner PVC casing (TIC) elevations, and top of outer protective casing (TOC) elevations. The elevations (NAVD 88) were reported to the nearest hundredth of a foot based on first order survey benchmarks. Location coordinates were reported using both the Global Positioning System (GPS) geographic coordinates to the nearest 0.01 second and the New Jersey State Plane Coordinate System (NAD 83) to the nearest 0.01 foot. Monitoring Well Certification Form Bs are included in Attachment 3 included on the accompanying CD.

In addition to monitoring wells, Weston sited two elevation control points (designated as Control Monuments [CM]) at strategic locations within the Dump Site to aid in the measurement of surface water elevations along White Sand Branch, which originates below Clement Lake and flows through the Dump Site. The elevation control points used for the Dump Site were located on the Route 561 bridge/culvert (designated CM-12) and the Clement Lake outlet structure (designated CM-13).

The control monuments also were surveyed by T&M Associates to establish horizontal location and vertical elevation data. The elevations (NAVD 88) were reported to the nearest hundredth of a foot based on first order survey benchmarks. Monument survey location coordinates were reported in both the GPS geographic coordinates to the nearest 0.01 second and the New Jersey State Plane Coordinate System (NAD 83) to the nearest 0.01 foot.

Groundwater and Surface Water Elevation Measurements

Between October 2005 and March 2006, Weston conducted groundwater elevation monitoring events using the Dump Site wells. After the elevation control points were designated and surveyed, Weston also conducted an additional round on September 12, 2006 to collect synoptic groundwater and surface water elevation measurements.

A Solinst® oil-water interface probe was used to measure depth to water (DTW) in the monitoring wells. Depth to water was measured in relation to the wells' TIC. Surface water elevations were obtained in September 2006 at four locations (DS01, DS02, DS03, DS04) using a level (David White Model 8824) and survey rod. The surface water elevation was calculated to the nearest 0.01 foot in relation to the elevation of the elevation control point.

Groundwater elevations were calculated by subtracting the measured DTW from the TIC elevation. The groundwater and surface water elevation data were used to construct groundwater contour maps for the Dump Site. A summary of the measured depth to water, groundwater elevation, and surface water elevation data for the Dump Site is given in Table 3 included on the accompanying CD.

Based on the groundwater measurements, the groundwater within the Dump Site is unconfined. At DMMW0001, located in an upland portion of the Dump Site, the DTW ranged from approximately 5.5 to 7.4 feet bgs. Between October 2005 and September 2006, a seasonal groundwater fluctuation of approximately 1.9 feet was measured at DMMW0001. DMMW0002 and DMMW0003 are located in topographically lower portions of the Dump Site. The DTW at DMMW0002 ranged from approximately 0.2 to 0.6 feet bgs. At DMMW0003 the DTW ranged from approximately 0.2 to 0.6 feet above ground surface. Seasonally, groundwater fluctuated less than 0.5 feet at DMMW0002 and DMMW0003 between October 2005 and September 2006.

Groundwater Contour Maps

The groundwater contours were designed using hand contouring techniques. Surface water elevation data (September 2006 only) were used as control elevation points to aid in the groundwater contour design in the vicinity of creeks and water bodies. Groundwater contour maps for three select events of groundwater monitoring are presented in Figures A-1 through A-3. The November 2005, January 2006, and September 2006 events were selected because they are representative of expected seasonal fluctuations in shallow groundwater.

A springtime event, March 2006, was not contoured because the depth to water measurements at DMMW0001 and DMMW0002 were not consistent with the other six rounds of groundwater measurements (Table 3). Based on Sherwin-Williams review of the data, it appears that the depth to water measurements at DMMW0001 and DMMW0002 were inadvertently transposed during the March 2006 field event.

Groundwater contour maps from November 2005, January 2006, and September 2006 were used to assess groundwater flow directions and calculate average horizontal hydraulic gradients across the Dump Site. Based on the groundwater contour maps the inferred groundwater flow direction is generally from the perimeter of the Dump Site, towards the axis of the stream channel and perpendicular to the topographic contours.

Hydraulic Conductivity Tests

Slug tests were performed at all three Dump Site wells (DMMW0001, DMMW0002 and DMMW0003) on September 8, 2005 to obtain representative average horizontal hydraulic conductivity values. At each monitoring well two rising head and two falling head slug tests were performed to ensure reproducibility.

An In-Situ® miniTROLL® 9000 data logger with a 15 pounds per square inch (PSI) pressure/level and temperature sensor was used to collect continuous water displacement measurements from the monitoring wells during the slug tests. A Solinst® electronic water level meter was used to measure initial depth to groundwater prior to slug testing and determine how far into the water column the slug needed to be lowered. The slug consisted of a 3-foot-long PVC pipe (1-inch ID, 1.13-inch OD) filled with cement and sealed on both ends with PVC caps. The volume of the slug was calculated to be 53.33 cubic inches (in^3).

Groundwater displacements were recorded continuously at one-second intervals, first with the slug placed in (i.e., falling head test) and then with the slug taken out (i.e., rising head test) of the well. This procedure was repeated once (slug-in1, slug-out1, slug-in2 and slug-out2) for each well for verification of data consistency. The slug test data were recorded in real time with the miniTROLL-interfaced palm computer data logger.

Once the field data were collected, aquifer test results were interpreted at Weston's Edison, New Jersey office using software (Aqtesolv® – v-4.50.002) that provided plots for visual curve-matching of aquifer straight-line solutions to time-displacement data measured during the field tests using various analytical methods that are discussed in the following section.

Site-Specific Aquifer Test Assumptions and Results

Based on Weston's previous experience at the site, the aquifer is assumed to be unconfined and isotropic near the surface with a saturation thickness of approximately 30 feet (lithological transition of upper saturated sands, gravels and silt layers with underlying very fine, compacted, micaceous sands) beneath the site.

Of the three wells installed in the Dump Site, one well (DMMW0001) has a partially submerged screen so a gravel pack correction using a porosity value of 30% was applied during the data analysis to account for drainage from the gravel pack. As applicable, the straight line fit to the second linear segment of the solution was selected for the hydraulic conductivity estimate.

The remaining two wells (DMMW0002 and DMMW0003) have screens fully submerged in the aquifer so a gravel pack correction for partially submerged screens was not required for DMMW0002 and DMMW0003.

Slug test data were evaluated by five analytical methods including:

- Bouwer and Rice (1976),
- Hvorslev (1957);
- Hyder et al. (also known as KGS Model) (1994);
- Dagan (1978); and
- Springer-Gelhar (1991).

The basic assumptions used for all of these methods include:

- Aquifer has infinite areal extent
- Aquifer is homogeneous and of uniform thickness
- Test well is fully or partially penetrating
- Aquifer is unconfined
- Flow to well is quasi-steady-state (storage is negligible)
- Volume of slug, V, is injected into or discharged from the well instantaneously
- Flow is unsteady (KGS method only)
- Water is released instantaneously from storage with decline of hydraulic head (KGS method only).

For each method, the Aqtesolv® definitions and assumptions are provided in Attachment 4 included on the accompanying CD.

Aqtesolv® 4.50.002 Professional was used for the solution calculations and curve fitting. All graphical solutions are provided as Attachment 5 included on the accompanying CD. The results of all the slug test methods are provided as Table 4 included on the accompanying CD. Arithmetic means of each solution method are provided for each well. The geometric means (using the arithmetic means from each well) are provided for each method used.

Because the Bouwer and Rice (1976) method is generally accepted given the site conditions (i.e., unconfined aquifer with partially penetrating wells), these data were used as a benchmark for the comparison of other slug test solution methods. The Bouwer and Rice (1976) results indicate an estimated hydraulic conductivity range of approximately 0.8 – 5.2 ft/day for the shallow groundwater.

The Hvorslev (1951) and Dagan (1978) methods yielded results greater than or equal to the results calculated using the Bouwer and Rice (1976) estimates. The Hvorslev (1951) estimated range of approximately 1.2 – 8.5 ft/day. The Dagan (1978) estimated range is approximately 0.8 – 6.9 ft.day.

The KGS (1994) and Springer-Gelhar (1991) methods yielded consistently lower results than the Bouwer and Rice (1976) estimates. The combined estimated range of the KGS (1994) and the Springer-Gelhar (1991) methods is 0.7 – 1.8 ft/day.

A linear correlation plot of the slug test data is provided (Attachment 5, Figure 1) and for each well an assessment of the precision of each method was made based on the relative standard deviation (Attachment 5, Table 1). The median was used for this evaluation because it is less affected by outlier data than the mean. The precision was very low for all methods at DMW0001 and DMW0003. Precision was moderate to high for all methods used to estimate hydraulic conductivity at DMW0002. The highest precision was experienced for the Bouwer and Rice (1976) method at DMW0002.

The statistical analysis of precision has generally shown the Bouwer and Rice (1976) method yields a higher level of precision at wells DMMW002 and DMMW003 than the other methods used. The lower precision calculated at well DMMW001 using the Bouwer and Rice (1976) estimates relative to the other method estimates may be caused by the inclusion of falling head solutions where the entire screen interval is not saturated.

Recommendations for Hydraulic Conductivity

Sherwin-Williams has evaluated various slug test methodologies and based upon that evaluation recommends that the Bouwer and Rice (1976) Method be used for any future site-specific calculations (e.g., seepage velocity) which require an estimated hydraulic conductivity parameter. Depending on the use of calculation, either well-specific arithmetic mean values or site-specific geometric mean values may be applied. As previously discussed, these values are summarized in Table 4. The Bouwer and Rice (1976) solution is selected because: 1) this most commonly used method is generally accepted by EPA for unconfined aquifers; 2) the differences between all solutions evaluated were less than an order of magnitude; and 3) the Bouwer and Rice (1976) results have a high precision relative to the other methods.

Site-Specific Groundwater Horizontal Hydraulic Gradient

Based on the topography different gradients may be calculated depending upon the location of the well and its relative location to the other wells (or measuring points) within the Dump Site.

For the purpose of estimating a site specific value, horizontal hydraulic gradients were calculated using various wells and measuring points located throughout the site. The intent is to calculate a gradient from the highest to lowest elevation in a direction parallel to the axis of stream flow and perpendicular to the topography. The elevation data from the September 2006 gaging event was used for these calculations.

In order to calculate a horizontal hydraulic gradient parallel to the axis of the stream, the surface water elevation data from measuring points DS-02 (located upstream adjacent to Clement Lake) and DS-04 (located downstream at the culvert exiting the Dump Site) were used. The horizontal hydraulic gradient calculated using the streamflow measuring points was calculated to be 0.009 ft/ft for the September 2006 event.

In addition to this, a separate gradient in a downgradient direction that is perpendicular to the topography was also calculated using DMMW0001 (located upgradient adjacent to the Wawa strip mall) and DS-04 (located downgradient at the culvert exiting the Dump Site). The horizontal hydraulic gradient estimated using data from DMMW0001 and DS-04 was calculated to be 0.018 ft/ft for the September 2006 event.

Site-Specific Groundwater Seepage Velocity

In order to calculate the range of seepage velocities, the hydraulic conductivity values derived from the Bouwer and Rice Method discussed above were used. The data from the September 12, 2006, gaging event were chosen as representative of site conditions and were subsequently used in the seepage velocity calculations. The seepage velocity is calculated by:

$$v = \frac{K(dh)}{n(dl)}$$

where,

v = seepage velocity
K = hydraulic conductivity
dh/dl = horizontal hydraulic gradient
n = porosity = 0.3

A seepage velocity was calculated for both of the horizontal hydraulic gradient regimes discussed in the previous section using the respective hydraulic conductivity calculated by the Bouwer and Rice (1976) method for each well. A separate calculation was also performed using the site geometric mean calculated using Bouwer and Rice (1976).

When calculating the seepage velocity using the horizontal gradients determined from DS-02 to DS-04 (along the axis of the stream), the seepage velocity ranged from 0.02 to 0.04 ft/day. When the site geometric mean K value (1.694 ft/day) was used, the seepage velocity was calculated as 0.05 ft/day.

When calculating the seepage velocity using the horizontal gradients determined from DMMW0001 to DS-04, the seepage velocity ranged from 0.08 to 0.32 ft/day. The seepage velocity of 0.32 ft/day was calculated using the hydraulic conductivity of 5.222 ft/day from DMMW0001. Upon inspection of the boring logs for this well, it is likely that this high K (relative to the other wells on-site) may be attributed to the less dense and looser soils in the vicinity of this well.

When the site geometric mean K value (1.694 ft/day) was used, the seepage velocity was calculated as 0.10 ft/day.

A summary of the seepage velocity calculations using the hydraulic conductivity derived from the Bouwer and Rice (1976) solutions is presented in Table 5 included on the accompanying CD.

Given the difference in ground water seepage velocities between the side slope of the Dump Site compared to the axis of the stream, ground water would be expected to be seeping from the side slopes since it cannot exit the valley as fast as ground water flows into the valley. This condition is present to some degree as illustrated by the artesian conditions documented in well DMMW0003 where the DTW ranged from approximately 0.2 to 0.6 feet above ground surface. In addition, the axis of the stream is a marshy area where ground water is present at the surface continually supplying water to White Sands Branch. However, due to the likely variability in porosity throughout the shallow water bearing zone (compared to the value used in the seepage velocity calculations) and the higher conductivity value calculated in well DMMW0001 the mathematical representations suggest much more extreme conditions should be present at the site.

Groundwater Sampling

The Dump Site wells were sampled approximately one month apart during two separate events in August and September 2005.

During the sampling events, all monitoring wells were purged and sampled using a micro-purge bladder pump equipped with new, dedicated Teflon® discharge tubing. All sampling equipment was decontaminated prior to initial use, between each sampling location, and after completion of the groundwater sampling event. Severn Trent Laboratories (STL) conducted the sampling events and collected all field parameters under supervision of Weston. STL is an NJDEP certified laboratory (certification number 12028).

The wells were purged and sampled following the EPA low-flow groundwater sampling protocols and consistent with NJDEP protocols. While the monitoring wells were being purged, the water quality parameters of temperature, pH, Eh, dissolved oxygen and specific conductivity were monitored using the Hach Sensor 1 multi-parameter water quality meter every three to five minutes until stabilization was achieved. Another parameter, turbidity, was monitored separately during purging using a LaMotte Model 2020 turbidity meter. Depth to water was monitored using a Solinst® electronic water level meter. A Solinst® interface probe was also used for groundwater-level monitoring to check for the presence of non-aqueous phase liquids (NAPLs) in groundwater. All purging parameter observations were recorded noting the presence of discernible odors and visible sheens. A PID (MultiRAE Plus) was used to measure the presence of volatile organic compounds (VOCs) in the well casings prior to any well monitoring.

Following collection in the field, groundwater samples were immediately transferred to a cooler with ice. A chain-of-custody was created at the end of each sampling event and delivered with the samples to STL in Edison, NJ. The analytical requirements for groundwater samples included Contract Laboratory Program (CLP) analyses (VOC+15, BNA+25, PCB, PCP, metals, cyanide) and a number of monitoring of natural attenuation (MNA) parameters (CO^2, TOC, TDS, TSS, Fe^{2+}, sulfide, sulfate, nitrate, nitrite, alkalinity, methane, ethane, ethene and chloride). A 4-week turnaround time was requested for the analyses.

In addition to investigative samples, quality assurance/quality control (QA/QC) samples were collected in accordance with Weston's Quality Assurance Project Plan (QAPP). Blind field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples were collected at a rate of one per 20 samples per analytical parameter. Field blanks were collected minimally once per event and analyzed for the same parameters as the field samples. Trip blanks (laboratory deionized water) were analyzed for VOCs once per shipment.

The groundwater sampling analytical results were previously submitted under separate cover in the document entitled *Evaluation of Strategic Sampling Results, Route 561 Dump Site* (May 23, 2006).

Proposed Monitor Well Installation

Presently, there are three shallow wells located within the Dump Site fenced area that were installed during the RI activities conducted in July 2005. As discussed during the December 18, 2008 Gibbsboro project meeting, EPA is recommending eleven new wells be installed to supplement the three existing shallow wells.

These eleven wells are comprised of 4 well couplets, 2 deep wells and 1 shallow well. The 4 well couplets are proposed at 3 off-site locations in addition to 1 location within the Dump Site. The 2 deep wells are intended to be co-located at existing shallow well locations (DMMW0001 and 0003) to form couplets. There is 1 shallow well proposed within the fenced area near the northeastern fence line adjacent to Clement Lake. These locations are presented on the attached Figure A-4.

On March 25, 2009, Ray Klimcsak (EPA) along with Patrick Austin and Arthur Fischer (both Weston) inspected the proposed locations that Weston and the drilling subcontractor (ECDI) marked out the previous week. Due to accessibility issues, there were three locations identified that would require the proposed monitor well locations to be shifted. They are as follows:

- Due to the proximity of underground and overhead utilities, it is suggested that the proposed well cluster on Marlton Avenue be shifted approximately 30 feet from the south side of the street to the north side of the street.

- Due to the proximity of a large tree, the proposed well cluster next to the Medical Arts Building (across Route 561 from the Dump Site) will need to be shifted approximately 10 to 20 feet in a northeasterly direction towards Route 561.

- Due to its location in an inaccessible area of the wetlands (soft, wet soils), it is suggested that the proposed well cluster in the middle of the site (near the base of the slope where the culvert from the Wawa parking lot runs) be shifted upslope approximately 50 feet to a more accessible, stable area.

As a result of this site walk, EPA concurred with the re-location of the well clusters located on Marlton Avenue and next to the Medical Arts Building. However, in lieu of the monitoring well cluster in the middle of the site (near the intermittent stream), EPA is requesting that three or four pore water samples be collected along the intermittent stream.

The revised monitoring well and pore water locations are presented on the attached Figure A-5.

The shallow wells will be completed within 15 feet of the ground surface and the deep wells will be screened from 25 to 35 feet bgs. It is not anticipated that the deep wells will need to be double-cased, though this option will be dependent upon the observed geology and site conditions. The present assumption is that both the shallow and deep wells will be screened in the same hydrogeologic unit at different depths.

The monitor wells will be installed using a Geoprobe® rig capable of hollow-stem auger (HSA) borings. Prior to the well installation, continuous split spoons or MacroCore® acetate sleeves will be collected and all cores will be field-screened at 2-foot intervals with a photoionization detector (PID) and x-ray fluorescence (XRF) unit. The geology will be logged by a qualified field geologist and visual observations such as staining will be noted. For each newly installed well, a soil sample will be collected from the midpoint of the screened interval or from the soils exhibiting the highest PID or XRF readings from within the proposed 10-foot screened interval, and submitted to the laboratory for TAL Metals, cyanide and total organic carbon (TOC) analysis.

In locations where a shallow and deep well couplet is to be installed, continuous logging will only be performed for the deeper boring to its target depth (25 to 35 feet bgs) and the shallow well will be installed via blind drilling to its target depth (15 feet bgs). A soil sample will be collected from both the shallow and deep well boreholes. These samples will be collected from the midpoint of the screened interval or from the soils exhibiting the highest PID or XRF readings from within the proposed 10-foot screened interval. Soil samples for laboratory analysis will be collected as described above for both the shallow and deep well boring.

In cases where only a shallow well is to be installed, then continuous logging will be performed and a soil sample will be collected from the midpoint of the screened interval or from the soils exhibiting the highest PID or XRF readings from within the proposed 10-foot screened interval, and submitted for laboratory analysis as described above.

In cases where a deep well is to be installed adjacent to an existing shallow well to form a couplet, then the deep well will be logged continuously starting at the ground surface A soil sample will be collected from the midpoint of the screened interval or from the soils exhibiting the highest PID or XRF readings from within the proposed 10-foot screened interval, and submitted for laboratory analysis as described above.

Monitoring wells will be installed by over-drilling each soil boring location using 8-inch outside diameter (4.25-inch inside diameter) hollow-stem augers. The monitoring wells will be constructed using 2-inch-diameter, schedule-40 polyvinyl chloride (PVC) well screens and riser pipes. The well screens will be 10 feet in length with 0.010-inch (10-slot) slot sizes. The well filter pack will be constructed with Morie sand #1, and granulated bentonite will be used to fill the annular seal above the sand filter pack. The filter packs will be placed in the well borehole from approximately 1.0 foot below or at the bottom of the well screens up to approximately 1.0 to 2.0 feet above the screen. A finer Morie sand #00 will be used as a choke layer between the filter pack and the bentonite seal. The wells will be finished above grade using 6-inch diameter protective steel stick-up outer casings or as flush mount installations depending upon the location. Sloping concrete pads measuring approximately 2 feet by 2 feet and 4 inches to 6 inches thick will be placed around the protective outer casings to seal and secure the wells above ground. All wells will be marked with their respective identifications on steel tags held by steel collars around the well outer casings.

Monitoring Well Development

All monitoring wells will be developed prior to the sampling event and as per NJDEP requirements, a New Jersey-licensed well driller will be used to develop the wells. All wells will be developed as per the Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers (ASTM, 2005).

The newly installed monitoring wells will be developed in a similar matter as the 3 existing monitoring wells installed during Summer 2005. The monitoring wells will be developed following installation by using a surge block and small submersible pumps (Whale and/or Typhoon pumps). The pump initially will be placed at the bottom of the well screen and manually surged up and down at periodic intervals. A portable turbidity meter (LaMotte Model 2020) will be used to monitor water turbidity during well development. The turbidity meter will be calibrated in the field prior to well development using turbidity standards of 1 and 1,000 nephelometric turbidity units (NTU). Water will be collected directly from the dedicated polyethylene pump discharge tubing at 5-minute intervals for turbidity monitoring and the development water will be containerized in 55-gallon drums, labeled, and stored on site for future disposal.

The monitoring wells will be developed until the development water becomes silt-free and relatively clear based on the following protocol. If turbidity levels have improved to acceptable levels after two hours, the development will be considered complete. If turbidity levels have not improved, the development will continue for up to another two hours (for a total of four hours). If, after the four hour period, an improvement in turbidity is not observed, the well will be allowed to equilibrate overnight and the development will be performed again. If no improvement in turbidity levels is observed after the second attempt, the development effort will be terminated and the well will be allowed to rest for 2 weeks prior to being sampled.

In accordance with the NJDEP Field Sampling Procedures Manual, the development water generated in the field will be purged to the ground.

Monitor Well Sampling Round

Two rounds of sampling will be conducted 1 month apart for all newly installed and existing wells at the Dump Site. A synoptic round of water levels will be collected at all the wells prior to the sampling event. The monitoring wells will be sampled utilizing the same procedures as described for the sampling event conducted for the 3 existing monitor wells installed during Summer 2005. The wells will be purged and sampled following the U.S. Environmental Protection Agency (EPA) low-flow groundwater sampling protocols and consistent with NJDEP protocols.

While the monitoring wells are being purged, water quality indicator parameters including temperature, pH, Eh, dissolved oxygen and specific conductivity will be monitored using a multi-parameter water quality meter and flow-through cell. Readings will be collected every five minutes until stabilization has been achieved. Another parameter, turbidity, will be monitored separately during purging using a LaMotte Model 2020 turbidity meter. Depth to water will be monitored using a Solinst® electronic water level meter. A Solinst® interface probe also will be used to measure drawdown and to check for the presence of non-aqueous phase liquids (NAPLs) in groundwater. All purging parameter observations will be recorded noting the presence of discernible odors and visible sheens. A PID (MultiRAE Plus) will be used to screen for the presence of volatile organic compounds (VOCs) in the well casings prior to any well gaging or sampling.

The groundwater samples will be collected and submitted to the laboratory for Contract Laboratory Program (CLP) analyses for TAL metals, cyanide, TOC, TDS, and TSS.

In addition to investigative samples, quality assurance/quality control (QA/QC) samples will be collected in accordance with the Quality Assurance Project Plan (QAPP). Blind field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a rate of one per 20 samples per analytical parameter. Field blanks will be collected minimally once per event and analyzed for the same parameters as the field samples. Trip blanks (laboratory deionized water) will be analyzed for VOCs once per shipment.

In accordance with the NJDEP Field Sampling Procedures Manual, the development water generated in the field will be purged to the ground.

List of Tables (included on CD)

TABLE 1

MONITORING WELL CONSTRUCTION SUMMARY
SHERWIN-WILLIAMS
DUMP SITE
Gibbsboro, NJ

WELL ID	Aquifer Designation	NJDEP Permit No.	Installation Date	NJSPC NAD-83 North	NJSPC NAD-83 East	Outer Casing Type (S or F)	Well Diameter (in)	Total Well Depth (ft bgs)	Existing Grade (ft amsl)	TOC Elevation (ft amsl)	TIC Elevation (ft amsl)	TS Elevation (ft amsl)	BS Elevation (ft amsl)	Depth to TS (ft bgs)	Screen Length (ft)	Screen Slot (in)	Screen/Riser Type
DMMW0001	Shallow	3100070342	7/22/2005	365762.948	363521.652	S	2	15	96.90	100.54	99.48	94.48	84.48	5	10	0.010	sch. 40 PVC
DMMW0002	Shallow	3100070343	7/22/2005	365598.05	363805.904	S	2	12	90.01	93.51	92.55	90.55	80.55	2	10	0.010	sch. 40 PVC
DMMW0003	Shallow	3100070344	7/26/2005	365438.815	363415.523	S	2	13	85.78	89.04	88.07	85.07	75.07	3	10	0.010	sch. 40 PVC

NOTES:
- TOC - Top of Outer Casing
- TIC - Top of Inner Casing
- TS - Top of Screen
- BS - Bottom of Screen
- ft bgs - Feet Below Ground Surface
- ft amsl - Feet Above Mean Sea Level
- S - Stick-up protective steel outer casing
- F - Flushmount protective outer casing
- NJSPC NAD-83 - New Jersey State Plane Coordinates North American Datum 1983

TABLE 2

SUMMARY OF WELL DEVELOPMENT
SHERWIN-WILLIAMS
DUMP SITE
Gibbsboro - NJ

Well No.	Date	Starting Depth to Groundwater (ft-bgs)	Purge Rate (gpm)	Initial Turbidity (NTU)	Final Turbidity (NTU)	Volume Pumped (gallon)	Pumping Duration (hr:min)	Total Pumping Time (hr:min)
DMMW0001	07/25/05	6.69	0.8	>1000	2.8	40	0:50	0:50
DMMW0002	07/28/05	0.82	0.6	>1000	130	94	3:08	4:18
	08/01/05	0.17	2.0	>1000	55	50	1:10	
DMMW0003	07/28/05	0.29	1.7	>1000	7.5	78	0:45	0:45

NOTES:
NTU - Nephelometric Turbidity Unit
gpm - gallon per minute
ft-bgs - feet below ground surface

TABLE 3

GROUNDWATER AND SURFACE WATER ELEVATION DATA
SHERWIN-WILLIAMS
DUMP SITE
Gibbsboro - NJ

		Date:	10/11/2005		11/23/2005		1/5/2006		1/31/2006		2/20/2006		3/23/2006		9/12/2006	
LOCATION	**Reference**	**Reference Elevation (ft-amsl)**	**TIC DTW (ft)**	**Elevation (ft)**	**DTW (ft)**	**Elevation (ft)**	**DTW (ft)**	**Elevation (ft)**	**DTW (ft)**	**Elevation (ft)**	**DTW (ft)**	**Elevation (ft)**	**DTW (ft)**	**Elevation (ft)**	**DTW (ft)**	**Elevation (ft)**
Monitoring Well - ft-amsl																
DMMW0001	TIC	99.48	9.99	89.49	9.41	90.07	8.04	91.44	8.15	91.33	8.22	91.26	4.61***	94.87***	8.88	90.60
DMMW0002	TIC	92.55	2.96	89.59	3.13	89.42	2.72	89.83	2.75	89.80	2.87	89.68	9.72***	82.83***	2.97	89.58
DMMW0003	TIC	88.07	1.74	86.33	2.11	85.96	1.75	86.32	1.69	86.38	1.69	86.38	1.86	86.21	1.85	86.22
Surface Water - ft-amsl																
DS01*	CM-13	93.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	88.49
DS02*	CM-13	93.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	87.52
DS03**	CM-13	93.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	92.83
DS04*	DMMW-0003, TOC	89.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	83.47

NOTES:

TIC - Top of Inner Casing
TOC - Top of Outer Casing
DTW - Depth to Water
NA - No measurement
ft-amsl - feet above mean sea level
* - White Sand Branch Creek
** - Clement Lake
*** - DTW measurement is inconsistent with other tabulated events. Therefore, groundwater elevation data was not considered for contouring.

TABLE 4

SUMMARY OF HYDRAULIC CONDUCTIVITY TESTING
SHERWIN-WILLIAMS
DUMP SITE
Gibbsboro - NJ

Well No.	Test No.	Falling Head	Rising Head	Bouwer & Rice (1976) (ft/d)	Hvorslev (1951) (ft/d)	Hyder et al. (KGS) (1994) (ft/d)	Dagan (1978) (ft/d)	Springer-Gelhar (1991) (ft/d)
DMMW0001	Slug-In1	X		7.980	12.52	2.243	9.653	1.627
	Slug-In2	X		5.973	9.649	1.597	6.719	1.575
	Slug-Out1		X	3.364	5.690	1.366	5.035	2.746
	Slug-Out2		X	3.571	6.276	1.211	6.058	1.147
Arithmetic Mean for all DMMW0001 tests using Bouwer and Rice:				**5.222**	n/a	n/a	n/a	n/a
Arithmetic Mean for all DMMW0001 tests using Hvorslev:				n/a	**8.534**	n/a	n/a	n/a
Arithmetic Mean for all DMMW0001 tests using Hyder et al.:				n/a	n/a	**1.604**	n/a	n/a
Arithmetic Mean for all DMMW0001 tests using Dagan:				n/a	n/a	n/a	**6.866**	n/a
Arithmetic Mean for all DMMW0001 tests using Springer-Gelhar:				n/a	n/a	n/a	n/a	**1.774**
Arithmetic Mean for all **DMMW0001** tests and methods:				**4.800**				
DMMW0002	Slug-In1	X		0.752	1.103	0.769	0.894	0.712
	Slug-In2	X		0.778	1.276	0.791	0.866	0.662
	Slug-Out1		X	0.722	1.098	0.703	0.795	0.627
	Slug-Out2		X	0.728	1.122	0.739	0.882	0.622
Arithmetic Mean for all DMMW0002 tests using Bouwer and Rice:				**0.745**	n/a	n/a	n/a	n/a
Arithmetic Mean for all DMMW0002 tests using Hvorslev:				n/a	**1.150**	n/a	n/a	n/a
Arithmetic Mean for all DMMW0002 tests using Hyder et al.:				n/a	n/a	**0.750**	n/a	n/a
Arithmetic Mean for all DMMW0002 tests using Dagan:				n/a	n/a	n/a	**0.859**	n/a
Arithmetic Mean for all DMMW0002 tests using Springer-Gelhar:				n/a	n/a	n/a	n/a	**0.656**
Arithmetic Mean for all **DMMW0002** tests and methods:				**0.832**				
DMMW0003	Slug-In1	X		1.620	2.654	2.149	2.054	1.742
	Slug-In2	X		1.094	1.595	1.294	1.240	1.124
	Slug-Out1		X	1.104	1.697	1.363	1.319	1.191
	Slug-Out2		X	1.177	1.764	1.436	1.367	1.166
Arithmetic Mean for all DMMW0003 tests using Bouwer and Rice:				**1.249**	n/a	n/a	n/a	n/a
Arithmetic Mean for all DMMW0003 tests using Hvorslev:				n/a	**1.928**	n/a	n/a	n/a
Arithmetic Mean for all DMMW0003 tests using Hyder et al.:				n/a	n/a	**1.561**	n/a	n/a
Arithmetic Mean for all DMMW0003 tests using Dagan:				n/a	n/a	n/a	**1.495**	n/a
Arithmetic Mean for all DMMW0003 tests using Springer-Gelhar:				n/a	n/a	n/a	n/a	**1.306**
Arithmetic Mean for all **DMMW0003** tests and methods:				**1.508**				
SITE SUMMARY (Geometric mean using applicable arithmetic means)								
Bouwer and Rice method (ft/d):				**1.694**	n/a	n/a	n/a	n/a
Hvorslev method (ft/d):				n/a	**2.664**	n/a	n/a	n/a
Hyder et al. (KGS) method (ft/d):				n/a	n/a	**1.234**	n/a	n/a
Dagan method (ft/d):				n/a	n/a	n/a	**2.066**	n/a
Springer-Gelhar method (ft/d):				n/a	n/a	n/a	n/a	**1.150**
All Dump Site tests and methods (ft/d):				**1.676**				

TABLE 5

SUMMARY OF GROUNDWATER SEEPAGE VELOCITIES
SHERWIN-WILLIAMS
DUMP SITE
Gibbsboro - NJ

Bouwer and Rice Method

Seepage Velocity Estimate	Parameter	Units	Area of Site (DS-02 to DS-04)		
			K = MW-02	K = MW-03	K = Site Geometric Mean
	K	ft/day	0.745	1.249	1.694
Range	*dh/dl*	ft/ft	0.009	0.009	0.009
	v	**ft/day**	**0.02**	**0.04**	**0.05**

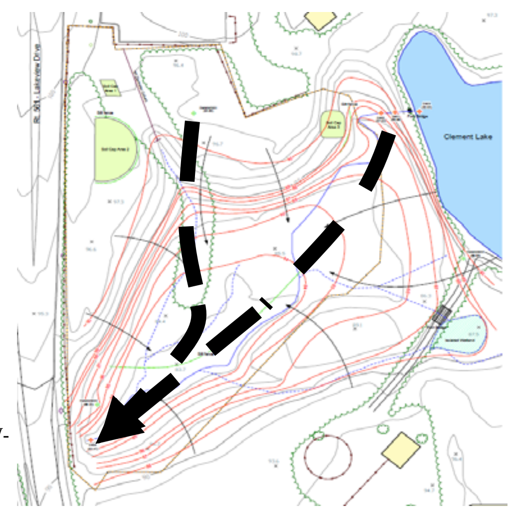
Seepage Velocity Estimate	Parameter	Units	Area of Site (MW-01 to DS-04)		
			K = MW-01	K = MW-03	K = Site Geometric Mean
	K	ft/day	5.222	1.249	1.694
Range	*dh/dl*	ft/ft	0.018	0.018	0.018
	v	**ft/day**	**0.32**	**0.08**	**0.10**

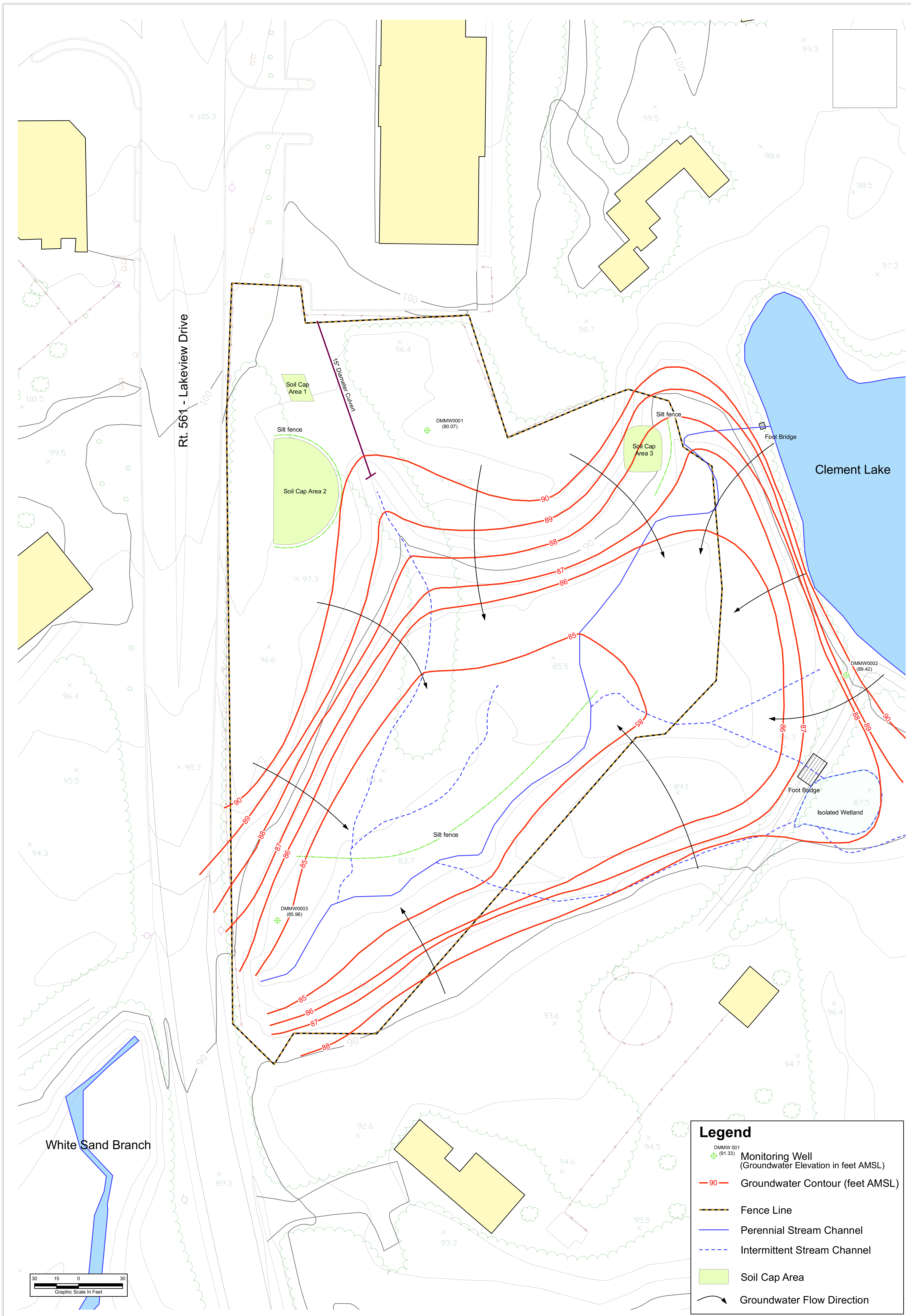
Notes:
v = seepage velocity
K = hydraulic conductivity (from Table 4)
n = porosity = 0.3
dh/dl = horizontal hydraulic gradient (calculated for September 12, 2006)

$$v = \frac{K\ (dh\ )}{n\ (dl\ )}$$

DS-02 to DS-04 - September 12, 2006 horizontal hydraulic gradient calculated along axis of stream path using surface water gaging stations. Range of seepage velocities calculated using individual K values for MW-02, MW-03 and the site geometric mean calculated using the Bouwer & Rice method (Table 4).

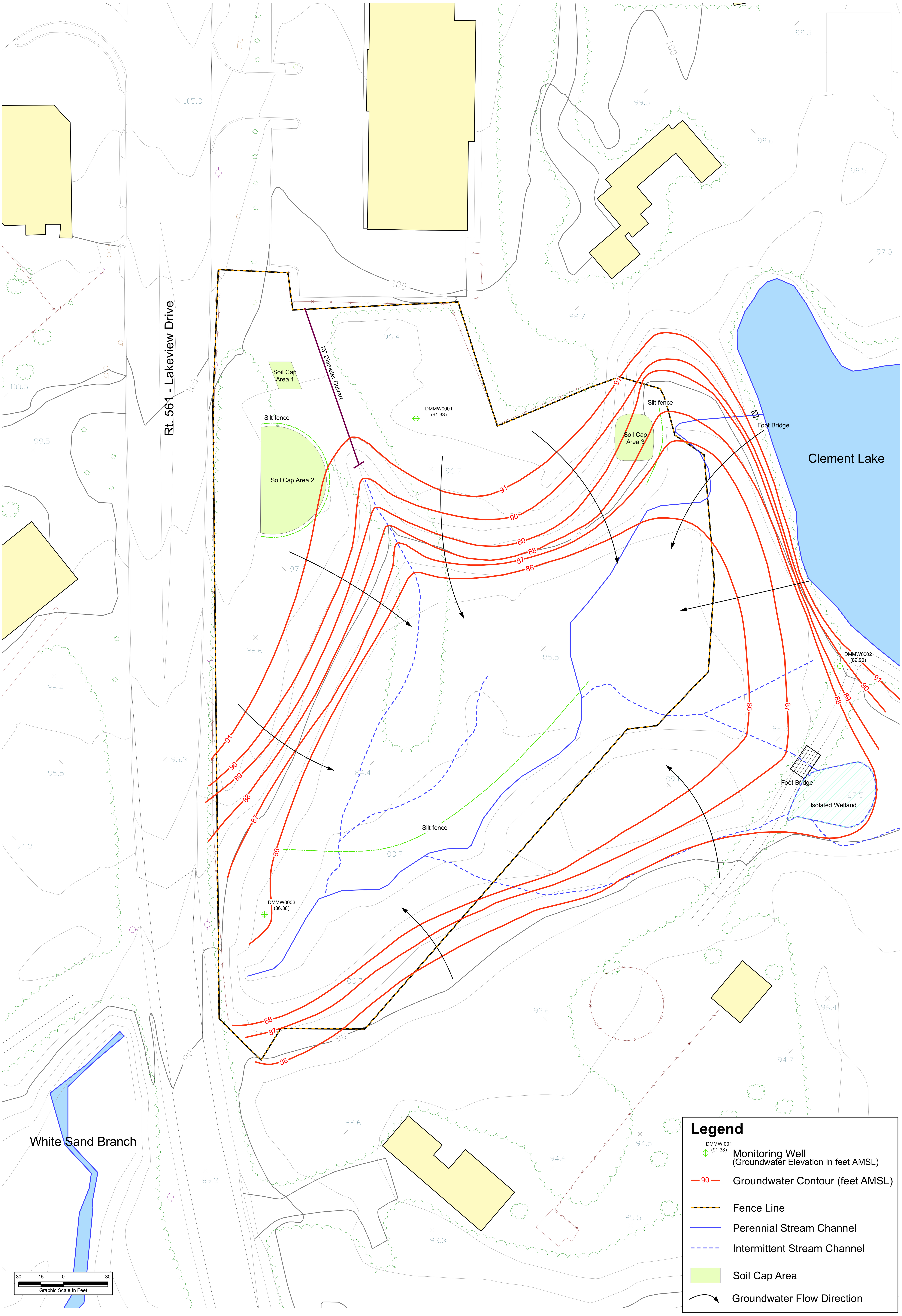
MW-01 to DS-04 - September 12, 2006 horizontal hydraulic gradient calculated from MW-1 over the path perpendicular to groundwater contours to the axis of the steam, and along the axis of the stream to DS-04. Range of seepage velocities calculated using individual K values for MW-01, MW-03 and the site geometric mean calculated using the Bouwer and Rice Method (see Table 4).





NOTE: Surface water elevation measurement points not established at the time of this event.

Weston Solutions, Inc. 205 Campus Drive Edison, New Jersey 08837-3939 TEL: (732) 417-5800 Fax: (732) 417-5801 http://www.westonsolutions.com	REPORT DATE: April 2009	PROJECT MANAGER: S. Jones	CLIENT NAME: The Sherwin-Williams Company	DRAWING TITLE: DUMP SITE GROUNDWATER CONTOUR MAP NOVEMBER 23, 2005
	DRAWING: 06556_DS_GW_Cont112305.mxd PATH: L:\SHERWIN\GIS\ MXD\0409_Contour_Maps\	CHECKED BY: A. Fischer		
	REVISION No. 0	CONTRACT No. DELIVERY ORDER NO.	PROJECT NAME: Sherwin-Williams Gibbsboro Remedial Investigation	
	WORK ORDER No. 20076.022.077.0005	DRAWN/MODIFIED BY: S. Poultney DATE CREATED: 7-25-08		FIGURE: A - 1 SCALE: 1" = 30' DATE: 4-29-09

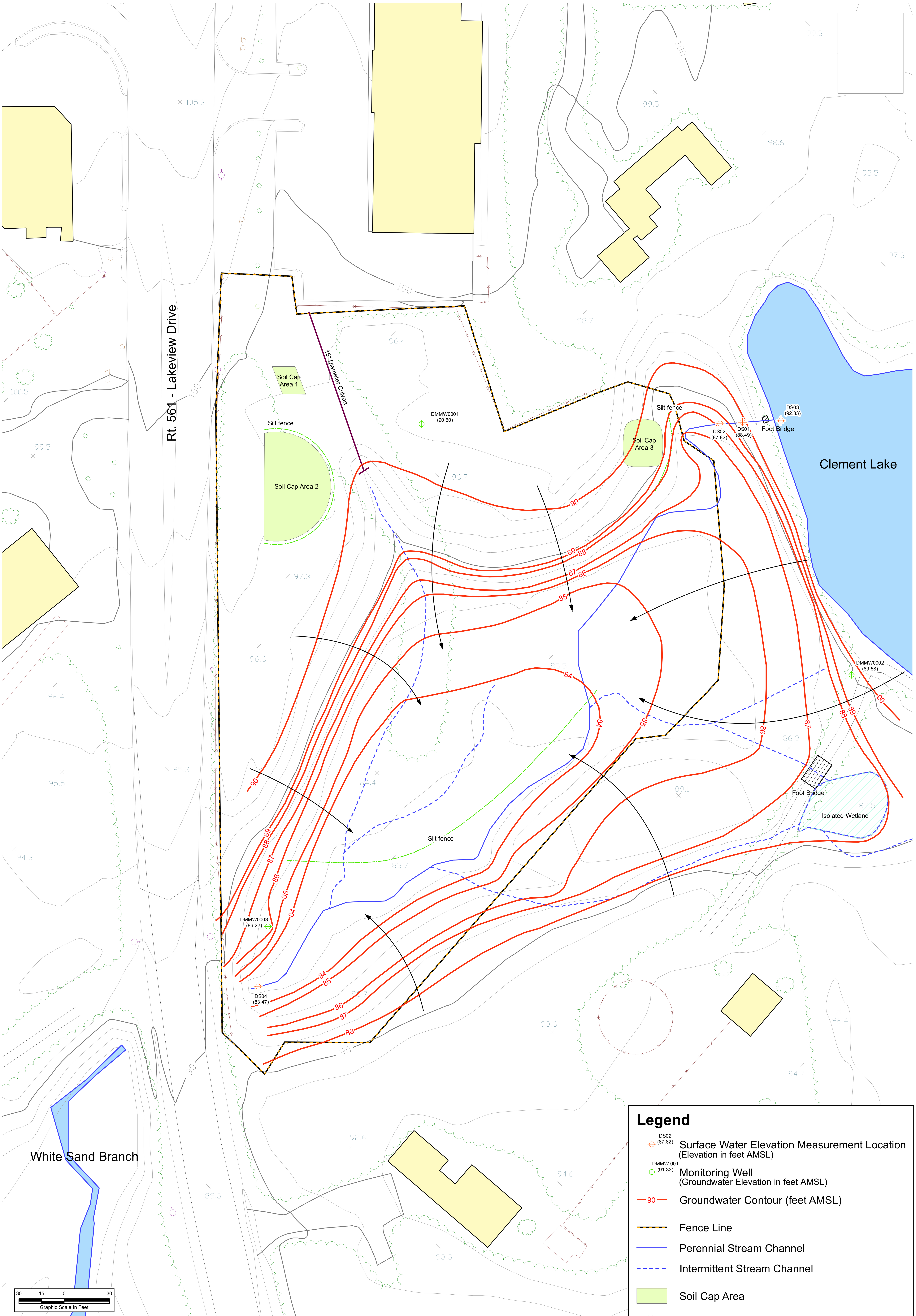


NOTE: Surface water elevation measurement points not established at the time of this event.

WESTON SOLUTIONS Weston Solutions, Inc. 205 Campus Drive Edison, New Jersey 08837-3939 TEL: (732) 417-5800 Fax: (732) 417-5801 http://www.westonsolutions.com	SHERWIN WILLIAMS	REPORT DATE: April 2009 DRAWING: 06558_DS_GW_Cont013106.mxd PATH: L:\SHERWIN\GIS\MXD\0409_Contour_Maps\ REVISION No. 0 WORK ORDER No. 20076.022.077.0005	PROJECT MANAGER: S. Jones CHECKED BY: A. Fischer CONTRACT No. DELIVERY ORDER NO. DRAWN/MODIFIED BY: S. Poultney DATE CREATED: 7-25-08	CLIENT NAME: The Sherwin-Williams Company PROJECT NAME: Sherwin-Williams Gibbsboro Remedial Investigation

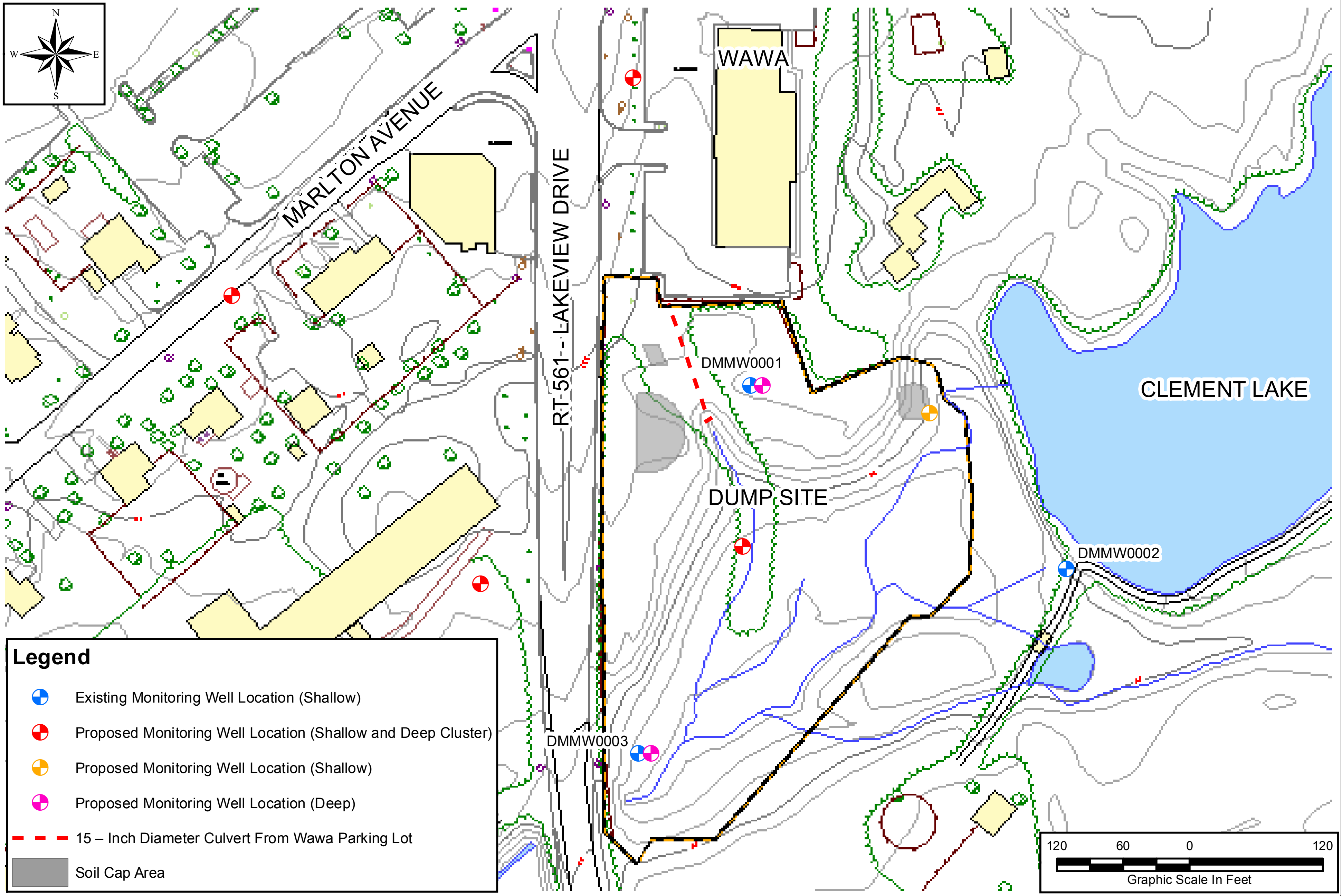
DRAWING TITLE:
DUMP SITE
GROUNDWATER CONTOUR MAP
JANUARY 31, 2006

FIGURE:	SCALE:	DATE:
A - 2	1" = 30'	4-29-09



Weston Solutions, Inc.
205 Campus Drive Edison, New Jersey 08837-3939
TEL: (732) 417-5800 Fax: (732) 417-5801
http://www.westonsolutions.com

REPORT DATE: April 2009	PROJECT MANAGER: S. Jones	CLIENT NAME: The Sherwin-Williams Company	DRAWING TITLE: DUMP SITE GROUNDWATER CONTOUR MAP SEPTEMBER 12, 2006
DRAWING: 06557_DS_GW_Cont091206.mxd PATH: L:\SHERWIN\GIS\MXD\0409_Contour_Maps\	CHECKED BY: A. Fischer		
REVISION No. 0	CONTRACT No. DELIVERY ORDER NO.	PROJECT NAME: Sherwin-Williams Gibbsboro Remedial Investigation	
WORK ORDER No. 20076.022.077.0005	DRAWN/MODIFIED BY: S. Poultney DATE CREATED: 7-25-08		FIGURE: A - 3 SCALE: 1" = 30' DATE: 4-29-09



L:\SHERWIN\GIS\MXD\0309_SW_Soil\06555_DS_EPA_Prop_MW.mxd

WESTON SOLUTIONS

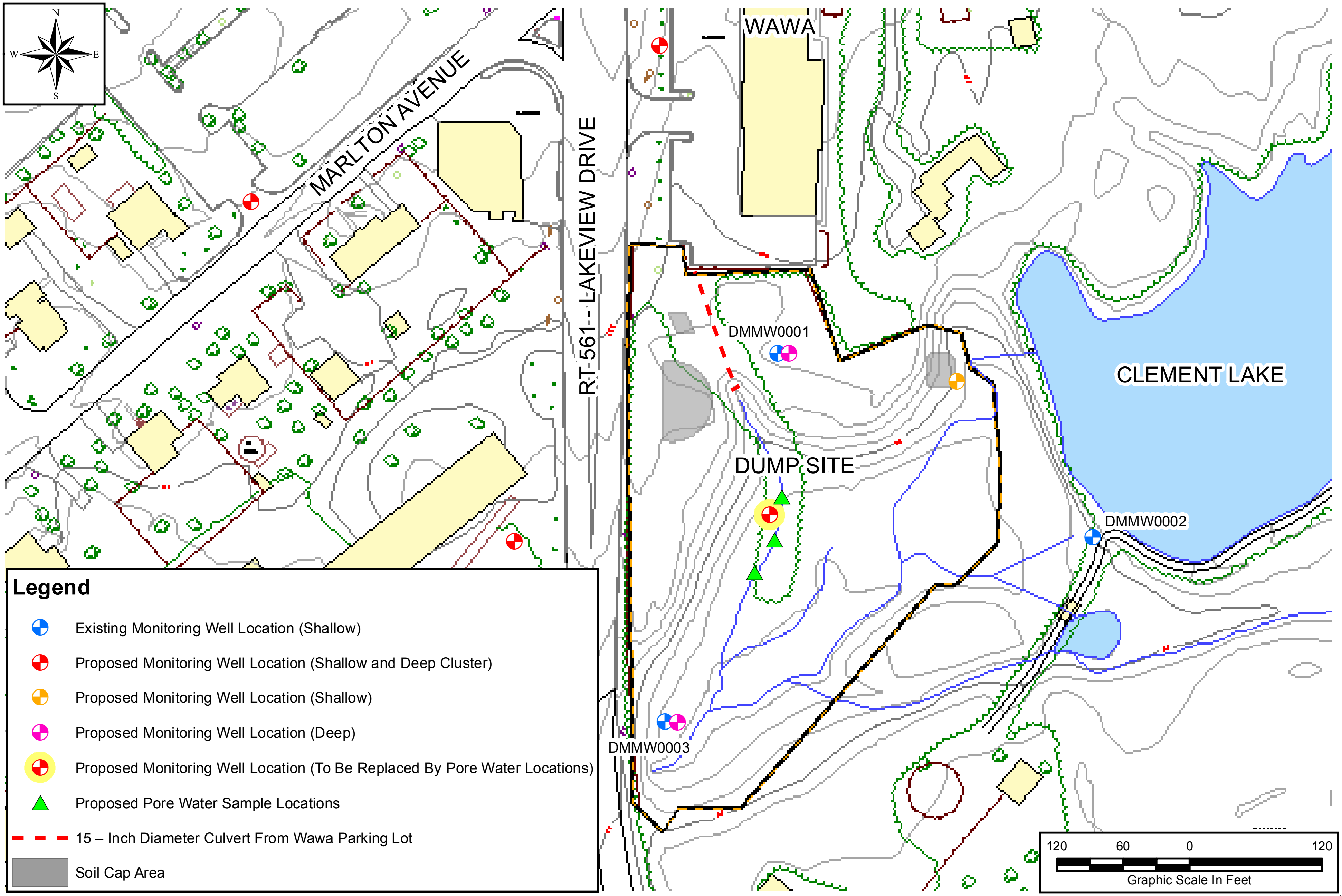
DATE: April 2009

FIGURE #: A - 4

PROJECT: Sherwin-Williams Gibbsboro Remedial Investigation

CLIENT NAME: The Sherwin-Williams Company

TITLE: Dump Site Proposed Monitoring Well Location Map (January 14, 2009 EPA Comment Letter)



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WESTON SOLUTIONS	PROJECT: Sherwin-Williams Gibbsboro Remedial Investigation	TITLE: Dump Site Revised Proposed Monitoring Well Location Map With Pore Water Locations (March 25, 2009 EPA Comment Letter)
DATE: April 2009	CLIENT NAME: The Sherwin-Williams Company	
FIGURE #: A - 5		

Attachment 1:
Soil Boring and Monitoring Well Construction Logs
(included on CD)

Contents

WESTON SOLUTIONS
Restoring Resource Efficiency
205 Campus Drive
Edison, NJ 08837
Phone: (732) 417-5800
Fax: (732) 417-5801

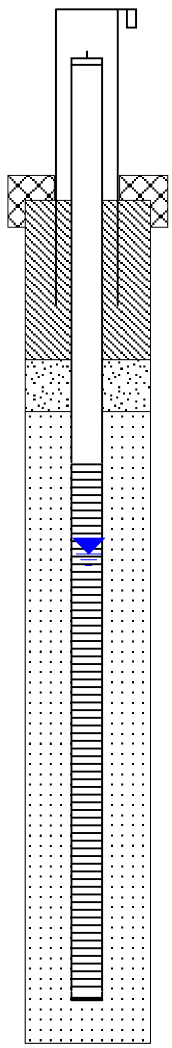
Log of Borehole: DMMW0001

Project: Gibbsboro - Dump Site
Client: Sherwin-Williams
Driller: ECDI - Steve Moylan
Well Permit #: 3100070342
Geologist/Logger: Gil Mello
Drilling Method: Hollow Stem Auger
Date Started: 7/22/05
Date Completed: 7/22/05
NAD 1983 Coordinates
Easting: 363521.652
Northing: 365762.948

SUBSURFACE PROFILE

Elevation (ft amsl)	Depth (ft bgs)	Description	USCS-ASTM
96.9	0	Ground Surface	
96.4	0.5	Grayish-brown SILT and fine sand. Dry, loose.	SM
		Light yellowish-brown medium to fine SAND. Dry, loose	SP
93.9	3	Light yellowish-brown coarse to medium SAND, little gravel. Dry, loose.	SW
91.9	5	Pale yellowish-brown GRAVEL and coarse to medium sand. Saturated, loose.	GP
85.9	11	Brownish-orange medium to fine SAND, little silt. Saturated, soft.	SP-SM
81.9	15	End of Borehole	

Well Construction



SAMPLE

Depth interval (ft bgs)	% Recovery	Soil Column PID (ppm)
0 - 5	80	0
5 - 10	50	0
10 - 15	50	0

Comments

NOTE:
Soil samples obtained with GEOPROBE 5' acetate sleeves for soil logging and PID screening prior to installation of monitoring well using Hollow Stem Auger.

6.69 ft bgs - Static groundwater on 7/25/05 before well development.

WELL DESIGN CONSTRUCTION:

Outer Casing Diameter / Type: 6" Steel Protective Stickup
Inner Casing Diameter / Type: 2" PVC
Screen / Slot Size: PVC 10 slot
Casing Grout Type: Concrete
Seal Type: Bentonite
Sand Pack Type 1: Morie # 00
Sand Pack Type 2: Morie # 1

IC-Interval: +2.58' - 5.0' bgs
SC-Interval: 5.0' - 15.0' bgs
GT-Interval: +0.5' - 1.0' bgs
ST-Interval: 0' - 2.0' bgs
SP1-Interval: 3.0' - 4.0' bgs
SP2-Interval: 4.0' - 16.0' bgs

Outer Casing Elevation (amsl): 100.54'
Inner Casing Elevation (amsl): 99.48'
Ground Elevation (amsl): 96.90'
Elevation Datum: NAVD 1988

WELL DEVELOPMENT:

Date: 7/25/05
Method: Overpumping
Initial Depth to Water: 6.69' bgs
Final Water Turbidity: 2.8 NTU
Pumping Rate: 0.8 gpm
Purged Volume: 40 gal

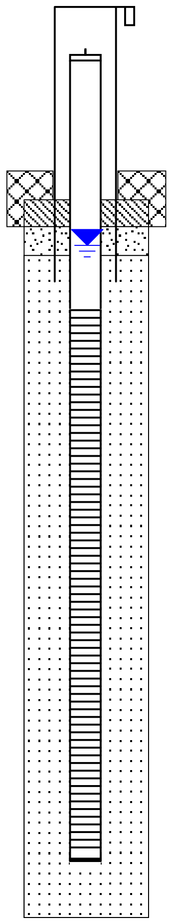
WESTON SOLUTIONS
Restoring Resource Efficiency
205 Campus Drive
Edison, NJ 08837
Phone: (732) 417-5800
Fax: (732) 417-5801

Log of Borehole: DMMW0002

Project: Gibbsboro - Dump Site
Client: Sherwin-Williams
Driller: ECDI - Steve Moylan | **Drilling Method:** Hollow Stem Auger | **NAD 1983 Coordinates**
Well Permit #: 3100070343 | **Date Started:** 7/22/05 | **Easting:** 363805.904
Geologist/Logger: Gil Mello | **Date Completed:** 7/22/05 | **Northing:** 365598.050

Elevation (ft amsl)	Depth (ft bgs)	Description	USCS-ASTM	% Recovery	Soil Column PID (ppm)	Comments
	-4					NOTES: Soil samples obtained with GEOPROBE 5' acetate sleeves for soil logging and PID screening prior to installation of monitoring well using Hollow Stem Auger.
90.0	0	Ground Surface				
	0 – 3	Dark brown medium to fine SAND. Moist, firm.	SW-SM	60	0	0.82 ft bgs - Static groundwater on 7/28/05 before well development.
87.0	3 – 5	Light grayish-brown coarse to fine SAND, trace silt, trace gravel. Wet, firm.	SW			
85.0	5 – 10	Yellowish-white medium to fine SAND. Mottled, saturated, dense.	SP-SM	60	0	
80.0	10 – 15	Yellowish-white medium to fine SAND. Saturated, dense.	SP-SM	60	0	
75.0	15	End of Borehole				

Well Construction



WELL DESIGN CONSTRUCTION:

Outer Casing Diameter / Type: 6" Steel Protective Stickup
Inner Casing Diameter / Type: 2" PVC
Screen / Slot Size: PVC 10 slot
Casing Grout Type: Concrete
Seal Type: Bentonite
Sand Pack Type 1: Morie # 00
Sand Pack Type 2: Morie # 1

IC-Interval: +2.54' - 2.0' bgs
SC-Interval: 2.0' - 12.0' bgs
GT-Interval: +0.5' - 0.5' bgs
ST-Interval: 0' - 0.5' bgs
SP1-Interval: 0.5' - 1.0' bgs
SP2-Interval: 1.0' - 13.0' bgs

Outer Casing Elevation (amsl): 93.51'
Inner Casing Elevation (amsl): 92.55'
Ground Elevation (amsl): 90.01'
Elevation Datum: NAVD 1988

WELL DEVELOPMENT:

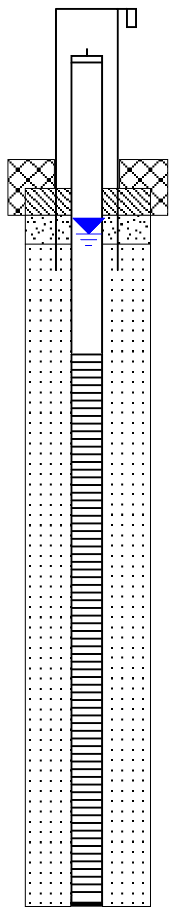
Date: 7/28/05 and 8/1/05
Method: Overpumping
Initial Depth to Water: 0.82' bgs
Final Water Turbidity: 55 NTU
Pumping Rate: 2.0 gpm
Purged Volume: 144 gal

WESTON SOLUTIONS
Restoring Resource Efficiency
205 Campus Drive
Edison, NJ 08837
Phone: (732) 417-5800
Fax: (732) 417-5801

Log of Borehole: DMMW0003

Project: Gibbsboro - Dump Site
Client: Sherwin-Williams
Driller: ECDI - Steve Moylan
Well Permit #: 3100070344
Geologist/Logger: Gil Mello
Drilling Method: Hollow Stem Auger
Date Started: 7/26/05
Date Completed: 7/26/05
NAD 1983 Coordinates
Easting: 363415.523
Northing: 365438.815

SUBSURFACE PROFILE					Well Construction	SAMPLE		Comments
Elevation (ft amsl)	Depth (ft bgs)	Soil Profile	Description	USCS-ASTM		% Recovery	Soil Column PID (ppm)	
	-4 to 0							NOTES: Soil samples obtained with GEOPROBE 5' acetate sleeves for soil logging and PID screening prior to installation of monitoring well using Hollow Stem Auger.
85.8	0		Ground Surface					
	0 - 2		Dark brown coarse to medium SAND, some silt, some gravel. Wet, soft.	SM				0.29 ft bgs - Static groundwater on 7/28/05 before well development.
83.8	2 - 5		Dark brown fine SAND and silt. Organics, wet, soft.	MH		60	0	
80.8	5 - 6		Yellowish-brown coarse to medium SAND, trace gravel. Mottled, saturated, firm.	SP		60	0	
79.8	6 - 15		Yellowish-orange fine SAND, some silt. Saturated, dense.	SM		50	0	
70.8	15		End of Borehole					



WELL DESIGN CONSTRUCTION:

Outer Casing Diameter / Type: 6" Steel Protective Stickup
Inner Casing Diameter / Type: 2" PVC
Screen / Slot Size: PVC 10 slot
Casing Grout Type: Concrete
Seal Type: Bentonite
Sand Pack Type 1: Morie # 00
Sand Pack Type 2: Morie # 1

IC-Interval: +2.29' - 2.0' bgs
SC-Interval: 3.0' - 13.0' bgs
GT-Interval: +0.5' - 0.5' bgs
ST-Interval: 0' - 0.5' bgs
SP1-Interval: 0.5' - 1.0' bgs
SP2-Interval: 1.0' - 13.0' bgs

Outer Casing Elevation (amsl): 89.04'
Inner Casing Elevation (amsl): 88.07'
Ground Elevation (amsl): 85.78'
Elevation Datum: NAVD 1988

WELL DEVELOPMENT:

Date: 7/28/05
Method: Overpumping
Initial Depth to Water: 0.29' bgs
Final Water Turbidity: 7.5 NTU
Pumping Rate: 1.7 gpm
Purged Volume: 78 gal

Attachment 2:
Monitoring Well Permits, Monitoring Well Records, and Monitoring Well Certification-Form A - As-Built Certifications

(included on CD)

Contents

NJDEP Monitoring Well Permits*, approved June 27, 2005 (1 page)

Well ID	Monitoring Well Record (dated 8/3/05)	Monitoring Well Form A	Total No. pages
DSMW0001**	●	●	2
DSMW0002**	●	●	2
DSMW0003**	●	●	2

Notes:

● = Included in this Attachment

*Monitoring Well Permit nos. for “DSMW001”, “DSMW002”, and “DSMW003” are issued on single NJDEP Monitoring Well Permit form DWR-133M. The drillers used a 3-numeral suffix for the well IDs, whereas Weston used a 4-numeral suffix. Therefore, as an example, “DSM001” referenced by the driller is the same monitoring well as “DMMW0001” referenced by Weston.

**The “DSMW” prefix used by the driller is equivalent to the “DMMW” prefix used by Weston. Therefore, as an example, “DSMW0001” referenced by the driller is the same monitoring well as “DMMW0001” referenced by Weston.

DWR-133M
11/01

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON, NJ

31000703442
31000703443
31000703444

MONITORING WELL PERMIT

Mail To:
NJDEP
BUREAU OF WATER ALLOCATION
PO BOX 426
TRENTON, NJ 08625-0426

Permit No. 31000703445

VALID ONLY AFTER APPROVAL BY THE D.E.P.

COORD #: 31.135.76

Owner Sherwin Williams Corp.Atn
Address 101 Prospect Ave N.W.
Cleveland, Ohio 44115-1075

Driller East Coast Drilling
Address 1256 N. Church St
Moorestown NJ 08057

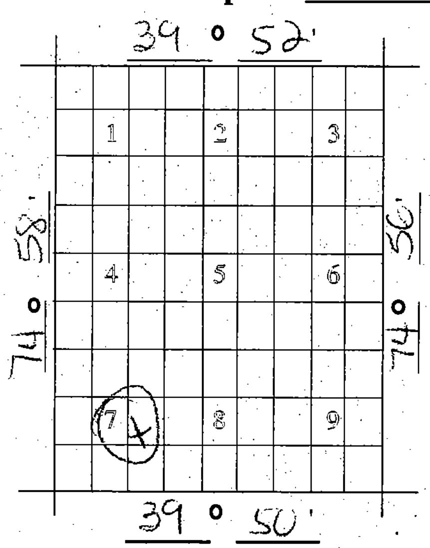
Name of Facility Paintworks Corp Center
Address 20 East Clementon Road
Gibbsboro, N.J. 08026

Diameter of Well(s) 2 Inches	Proposed Depth of Well(s) 15 Feet
# of Wells Applied for (max. 10) 4	Will pumping equipment be utilized? YES ☐ NO ☑
Type of Well (see reverse) Monitoring	If Yes, give pump capacity — cumulative GPM

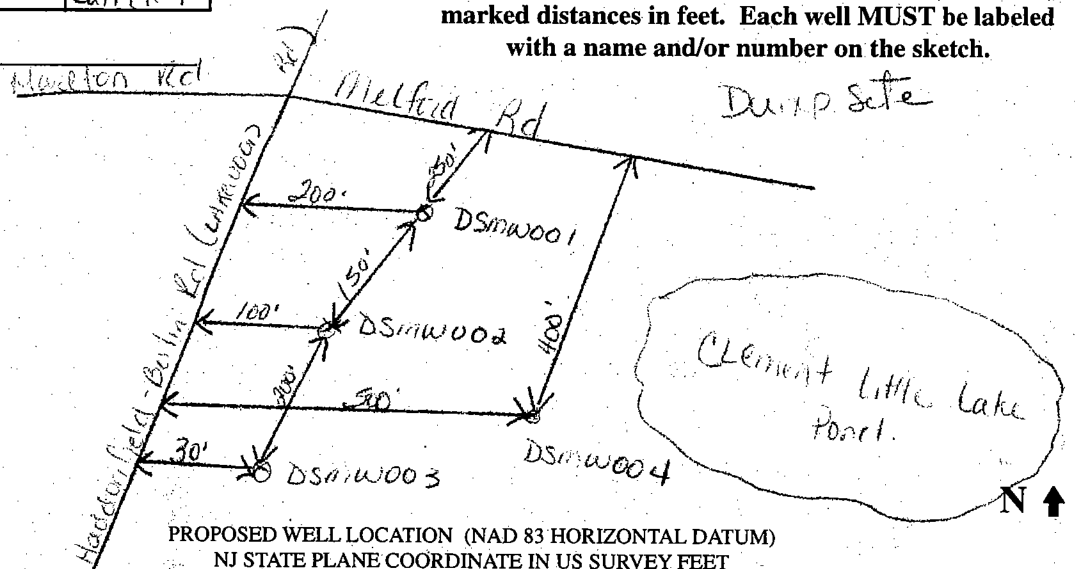
LOCATION OF WELL(S)

Lot #	Block #	Municipality	County
9-10	18.07	Gibbsboro	Camden

State Atlas Map No. 31



Draw sketch of well(s) nearest roads,buildings, etc. with marked distances in feet. Each well MUST be labeled with a name and/or number on the sketch.



PROPOSED WELL LOCATION (NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: _______	OR	EASTING: _______
LATITUDE: __°__'__"		LONGITUDE: __°__'__"

FOR MONITORING WELLS, RECOVERY WELLS, OR PIEZOMETERS, THE FOLLOWING MUST BE COMPLETED BY THE APPLICANT. PLEASE INDICATE WHY THE WELLS ARE BEING INSTALLED:

- ☐ RCRA Site
- ☐ Underground Storage Tank Site
- ☐ Operational Ground Water Permit Site
- ☐ Pretreatment and Residuals Site
- ☐ Water and Hazardous Waste Enforcement Case
- ☐ Water Supply Aquifer Test Observation Well
- ☑ Other (explain) Administrative Consent Order dated 9/26/90
- ☐ Spill Site
- ☐ ISRA Site
- ☐ CERCLA (Superfund) Site

CASE I.D. Number

This Space for Approval Stamp
WELL PERMIT APPROVED
N.J. D.E.P.
JUN 27 2005
BUREAU OF WATER ALLOCATION

FOR D.E.P. USE ☐ Issuance of this permit is subject to the conditions attached. (see next page) ☑ For monitoring purposes only
☐

SEE REVERSE SIDE FOR IMPORTANT PROVISIONS PERTAINING TO THIS PERMIT.
In compliance with N.J.S.A.58:4A-14, application is made for a permit to drill a well as described above.

Date 6/23/05 Signature of Driller James W. Nufffo Registration No. M1224
Signature of Property Owner Mary Lou Capecchioni

DSW00010

COPIES: Water Allocation - White Health Dept. - Yellow Owner - Blue Driller - White

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3100070342

Atlas Sheet Coordinates 3113576

OWNER IDENTIFICATION SHERWIN WILLIAMS COMPANY, INC.

Address 101 PROSPECT AVENUE, N.W.

City CLEVELAND State Ohio Zip Code 44115

WELL LOCATION - If not the same as owner please give address Owner's Well No. DSMW0001

County Camden Municipality Gibbsboro Boro Lot No. 9-10 Block No. 18.07

Address 20 EAST CLEMENTON ROAD PAINTWORKS CORP. CENTER

WELL USE Monitoring

DATE WELL STARTED 7-25-05

DATE WELL COMPLETED 7-25-05

WELL CONSTRUCTION

Total Depth Drilled 16 ft.

Finished Well Depth 15 ft.

Borehole Diameter:

Top 8 in.

Bottom 8 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 3 ft.

Steel protective casing installed? ☒ Yes ☐ No

Static Water Level after drilling 6.69 ft.

Water Level was Measured Using m-scope

Well was developed for .50 hours at .8 gpm

Method of development pump

Pump Capacity — gpm

Pump Type —

Drilling Fluid none Type of Rig DT66

Health and Safety Plan Submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None D C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+3	5	2	PVC	Sch40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	5	15	2	PVC	Sch40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	2.5 / 3	3 / 15		#00 / #0	
Grout	0	2.5		Neat Cement / Bentonite	94 lbs / 5 lbs

Grouting Method Tremie

Drilling Method H.S.A.

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-.5' - Gray/brn silt & clay F-sand
.5-3' - Lt yellow/brn M-F sand
3-5' - H yellow/brn M-C sand little gravel
5-11' - Lt yellow/brn gravel w/ C-M sand
11-16 - Brn/orange M-F sand

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company EAST COAST DRILLING, INC.

Well Driller (Print) Steve Mofan

Driller's Signature Steve Mofano

Registration No. JD22215 Date 8/3/05

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING:__________ **EASTING:**__________

OR

LATITUDE:__°__'__.__" **LONGITUDE:**__°__'__.__"

ORIGINAL: DEP ***COPIES: DRILLER OWNER HEALTH DEPARTMENT***

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3100070343

Atlas Sheet Coordinates 3113576

OWNER IDENTIFICATION SHERWIN WILLIAMS COMPANY, INC.

Address 101 PROSPECT AVENUE, N.W.

City CLEVELAND State Ohio Zip Code 44115

WELL LOCATION - If not the same as owner please give address Owner's Well No. DSMW0002

County Camden Municipality Gibbsboro Boro Lot No. 9-10 Block No. 18.07

Address 20 EAST CLEMENTON ROAD PAINTWORKS CORP. CENTER

WELL USE Monitoring

DATE WELL STARTED 7-22-05

DATE WELL COMPLETED 7-22-05

WELL CONSTRUCTION

Total Depth Drilled 14 ft.

Finished Well Depth 13 ft.

Borehole Diameter:

Top 8 in.

Bottom 8 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 3 ft.

Steel protective casing installed? ☒ Yes ☐ No

Static Water Level after drilling ,17 ft.

Water Level was Measured Using m-scope

Well was developed for 3 hours at 2 gpm

Method of development pumping

Pump Capacity — gpm

Pump Type —

Drilling Fluid None Type of Rig DTL6

Health and Safety Plan Submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None D C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+3	3	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	3	13	2	PVC	40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	~~1~~ .5	~~14~~ 14		~~#00~~ #0	
Grout	0	.5		Neat Cement / Bentonite	94 lbs / 5 lbs

Grouting Method Gravity Placement

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-3' - Dk brn M-F sand
3-5' - Lt gray brn C-F sand
5-10' - Yellow/Wht M-F sand
10-14' - Yellow wht M-F sand

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company EAST COAST DRILLING, INC.

Well Driller (Print) Steve Nolan

Driller's Signature Steve Nolan

Registration No. JD22215 Date 8/3/05

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING:________ EASTING:________

OR

LATITUDE: ___° ___' ___.___" LONGITUDE: ___° ___' ___.___"

ORIGINAL: DEP *COPIES: DRILLER OWNER HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3100070344

Atlas Sheet Coordinates 3113576

OWNER IDENTIFICATION SHERWIN WILLIAMS COMPANY, INC.

Address 101 PROSPECT AVENUE, N.W.

City CLEVELAND State Ohio Zip Code 44115

WELL LOCATION - If not the same as owner please give address Owner's Well No. DSMW0003

County Camden Municipality Gibbsboro Boro Lot No. 9-10 Block No. 18.07

Address 20 EAST CLEMENTON ROAD PAINTWORKS CORP. CENTER

WELL USE Monitoring

DATE WELL STARTED 7-26-05

DATE WELL COMPLETED 7-26-05

WELL CONSTRUCTION

Total Depth Drilled 13 ft.

Finished Well Depth 12 ft.

Borehole Diameter:

Top 8 in.

Bottom 8 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 3 ft.

Steel protective casing installed? ☒ Yes ☐ No

Static Water Level after drilling .29 ft.

Water Level was Measured Using m-scope

Well was developed for .5 hours at 1.66 gpm

Method of development pump

Pump Capacity gpm

Pump Type —

Drilling Fluid None Type of Rig DT66

Health and Safety Plan Submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None D C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+3	2	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	2	12	2	PVC	40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	.5 / 1	1 / 13		#00 / #0	
Grout	0	.5		Neat Cement / Bentonite	94 lbs / 5 lbs

Grouting Method Gravity Placement.

Drilling Method H.S.A.

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-3'. Dk brn C-sand
3-5' · Dk brn F-silty sand
5-13' - Dk brn F- silty sand

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company EAST COAST DRILLING, INC.

Well Driller (Print) Steve Moylan

Driller's Signature Steve Moylan

Registration No. JD22215 Date 8/3/05

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING:________ EASTING:________

OR

LATITUDE:__°__'__.__" LONGITUDE:__°__'__.__"

ORIGINAL: DEP ***COPIES: DRILLER OWNER HEALTH DEPARTMENT***

MONITORING WELL CERTIFICATION-FORM A- AS-BUILT CERTIFICATION
(One form must be completed for each well)

Name of Permittee: Sherwin Williams Company, Inc.
Name of Facility: Paintworks Corporate Center
Location: 20 East Clementon Road, Gibbsboro, Camden County, New Jersey
NJDES Permit No: ____________________

CERTIFICATION

Well Permit Number (As assigned by NJDEP's Well Drilling Permits Section, (609-984-6831)) :	3 1 0 0 0 7 0 3 4 2
Owner's Well Number (As shown on the application or plans):	DSMW0001
Well Completion Date:	7-25-05
Distance from Top of Casing (cap off) to ground surface (one-hundredth of a foot):	+3.00
Total Depth of Well (one-hundredth of a foot):	15.00
Depth to Top of Screen From Top of Casing (one-hundredth of a foot):	8.00
Screen Length (feet):	10'
Screen or Slot Size:	.010
Screen or Slot Material:	Sch 40 PVC
Casing Material: (PVC, Steel or Other-Specify):	Sch 40.PVC
Casing Diameter (inches):	2"
Static Water Level from Top of Casing at the Time of Installation (one-hundredth of a foot):	6.69
Yield (gallons per minutes):	0.80
Length of Time well Pumped or Bailed:	0 Hours 30 Minutes
Lithologic Log:	Attach

AUTHENTICATION

I certify under penalty of law that, where applicable, I meet the requirements as specified on the reverse of this page, that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

James W. Duffy
Name (Type or Print)

James W. Duffy
Signature

M1224
Certification or License No.

Seal

____
Certification by Executive Officer or Duly Authorized Representative

____
Name (Type or Print)

____
Signature

____
Title

____
Date

\\Eng4\drilling admin\Forms\Form A\31-70342.wpd

MONITORING WELL CERTIFICATION-FORM A- AS-BUILT CERTIFICATION

(One form must be completed for each well)

Name of Permittee: Sherwin Williams Company, Inc.
Name of Facility: Paintworks Corporate Center
Location: 20 East Clementon Road, Gibbsboro, Camden County, New Jersey
NJDES Permit No: ______________________

CERTIFICATION

Well Permit Number (As assigned by NJDEP's Well Drilling Permits Section, (609-984-6831)) :	3 1 0 0 0 7 0 3 4 3
Owner's Well Number (As shown on the application or plans):	DSMW0002
Well Completion Date:	7-22-05
Distance from Top of Casing (cap off) to ground surface (one-hundredth of a foot):	+3.00
Total Depth of Well (one-hundredth of a foot):	14.00
Depth to Top of Screen From Top of Casing (one-hundredth of a foot):	7.00
Screen Length (feet):	10'
Screen or Slot Size:	.010
Screen or Slot Material:	Sch 40 PVC
Casing Material: (PVC, Steel or Other-Specify):	Sch 40.PVC
Casing Diameter (inches):	2"
Static Water Level from Top of Casing at the Time of Installation (one-hundredth of a foot):	0.17
Yield (gallons per minutes):	2.00
Length of Time well Pumped or Bailed:	3 Hours 00 Minutes
Lithologic Log:	Attach

AUTHENTICATION

I certify under penalty of law that, where applicable, I meet the requirements as specified on the reverse of this page, that I have personally examined and am familiar with the information submitted in this document and all attachments, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

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Name (Type or Print)

James W Duffy
Signature

M1224
Certification or License No.

Seal

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Certification by Executive Officer or Duly Authorized Representative

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Name (Type or Print)

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Signature

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Title

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Date

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MONITORING WELL CERTIFICATION-FORM A- AS-BUILT CERTIFICATION

(One form must be completed for each well)

Name of Permittee: Sherwin Williams Company, Inc.
Name of Facility: Paintworks Corporate Center
Location: 20 East Clementon Road, Gibbsboro, Camden County, New Jersey
NJDES Permit No: ______

CERTIFICATION

Well Permit Number (As assigned by NJDEP's Well Drilling Permits Section, (609-984-6831)) :	3100070344
Owner's Well Number (As shown on the application or plans):	DSMW0003
Well Completion Date:	7-26-05
Distance from Top of Casing (cap off) to ground surface (one-hundredth of a foot):	+3.00
Total Depth of Well (one-hundredth of a foot):	12.00
Depth to Top of Screen From Top of Casing (one-hundredth of a foot):	5.00
Screen Length (feet):	10'
Screen or Slot Size:	.010
Screen or Slot Material:	Sch 40 PVC
Casing Material: (PVC, Steel or Other-Specify):	Sch 40.PVC
Casing Diameter (inches):	2"
Static Water Level from Top of Casing at the Time of Installation (one-hundredth of a foot):	0.29
Yield (gallons per minutes):	1.66
Length of Time well Pumped or Bailed:	0 Hours 45 Minutes
Lithologic Log:	Attach

AUTHENTICATION

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Name (Type or Print)

James W Duffy
Signature

M1224
Certification or License No.

Seal

______
Certification by Executive Officer or Duly Authorized Representative

______
Name (Type or Print)

______
Signature

______
Title

______
Date

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Attachment 3:
Monitoring Well Certification-Form B - Location Certifications
(included on CD)

Contents

Well ID	Form B (dated 5/23/06)	Total No. pages
DMMW0001	●	1
DMMW0002	●	1
DMMW0003	●	1

Note: ● = Form B included in this attachment

MONITORING WELL CERTIFICATION FORM B - LOCATION CERTIFICATION

Name of Owner: ____________________

Name of Facility: Sherwin Williams Site

Location: Gibbsboro, New Jersey

Case Number(s): ________________ (UST #, ISRA #, Incident #, or EPA #)

LAND SURVEYOR'S CERTIFICATION

Well Permit Number: 3100070342

(This number must be permanently affixed to the well casing.)

Owners Well Number (As shown on application or plans): DMMW-0001

Geographic Coordinate NAD 83 (to nearest 1/10 of second):

1983: Longitude: West 74° 57' 28.75" Latitude: North 39° 50' 12.12"

New Jersey State Plane Coordinates:

NAD 1983: North 365762.948 East 363521.652

Elevation of Top of Inner Casing (cap off) at reference mark (nearest 0.01'):		Outer Casing:	Existing Grade:
Permit Requirement NAVD 1988:	99.48	100.54	96.90
Reference NAVD 1929:	100.64	101.70	98.06

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximated actual elevation.)

____

Significant observations and notes: ____________________

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

SEAL

William E. Alburger

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

5-23-06

DATE

William E. Alburger N.J.P.L.S. No. 32106

PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

T&M Associates, 1256 North Church Street, Suite 3, Moorestown, NJ 08057

PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

T&M Project # WSIN00030

MONITORING WELL CERTIFICATION FORM B - LOCATION CERTIFICATION

Name of Owner: ______________________

Name of Facility: Sherwin Williams Site

Location: Gibbsboro, New Jersey

Case Number(s): ______________ (UST #, ISRA #, Incident #, or EPA #)

LAND SURVEYOR'S CERTIFICATION

Well Permit Number: 3100070343
(This number must be permanently affixed to the well casing.)

Owners Well Number (As shown on application or plans): DMMW-0002

Geographic Coordinate NAD 83 (to nearest 1/10 of second):
1983: Longitude: West 74° 57' 25.10" Latitude: North 39° 50' 10.50"

New Jersey State Plane Coordinates:
NAD 1983: North 365598.050 East 363805.904

Elevation of Top of Inner Casing (cap off) at reference mark (nearest 0.01'):		Outer Casing:	Existing Grade:
Permit Requirement NAVD 1988:	92.55	93.51	90.01
Reference NAVD 1929:	93.71	94.67	91.17

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximated actual elevation.)

____

Significant observations and notes: ______________________

AUTHENTICATION

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William E. Alburger

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

5-23-06

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PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

T&M Associates, 1256 North Church Street, Suite 3, Moorestown, NJ 08057
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

T&M Project # WSIN00030

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MONITORING WELL CERTIFICATION FORM B - LOCATION CERTIFICATION

Name of Owner: ______________________

Name of Facility: Sherwin Williams Site

Location: Gibbsboro, New Jersey

Case Number(s): ______________ (UST #, ISRA #, Incident #, or EPA #)

LAND SURVEYOR'S CERTIFICATION

Well Permit Number: 3100070344

(This number must be permanently affixed to the well casing.)

Owners Well Number (As shown on application or plans): DMMW-0003

Geographic Coordinate NAD 83 (to nearest 1/10 of second):

1983: Longitude: West 74° 57' 30.09" Latitude: North 39° 50' 08.91"

New Jersey State Plane Coordinates:

NAD 1983: North 365438.815 East 363415.523

Elevation of Top of Inner Casing (cap off) at reference mark (nearest 0.01'):		Outer Casing:	Existing Grade:
Permit Requirement NAVD 1988:	88.07	89.04	85.78
Reference NAVD 1929:	89.23	90.20	86.94

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximated actual elevation.)

____

Significant observations and notes: ______________________

AUTHENTICATION

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SEAL

William E. Alburger

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5-23-06

DATE

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T&M Project # WSIN00030

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Attachment 4:
AQTESOLV's Definitions and Assumptions for "Solutions for Slug Tests in an Unconfined Aquifer"

(included on CD)

Contents

Method	AQTESOLV's Definitions and Assumptions	Total No. pages
Bouwer-Rice (1976)	●	3
Dagan (1978)	●	3
Hvorslev (1951)	●	2
Hyder et al. (1994)	●	4
Springer-Gelhar (1991)	●	4

Note: ● = Definitions and assumptions included in this attachment

Bouwer-Rice (1976) Solution for a Slug Test in an Unconfined Aquifer

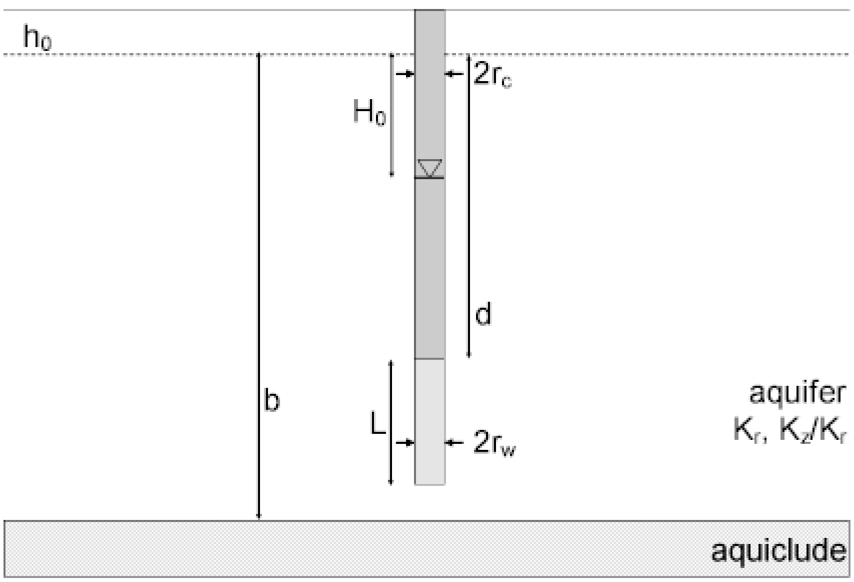
(Match > Solution)

Bouwer and Rice (1976) developed a semi-analytical method for the analysis of an overdamped slug test in a fully or partially penetrating well in an unconfined aquifer. The Bouwer-Rice method employs a quasi-steady-state model that ignores elastic storage in the aquifer.

In cases of noninstantaneous test initiation, apply the translation method of Pandit and Miner (1986) prior to analyzing the data.

If the test well is screened across the water table, you may apply an optional correction for the effective porosity of the filter pack. When the test well is fully submerged (i.e., screened below the water table) or the aquifer is confined, the correction is unnecessary.

- **Illustration**



- **Equations**

Bouwer and Rice (1976) developed an empirical relationship describing the water-level response in an unconfined aquifer due to the instantaneous injection or withdrawal of water from a well:

$$\ln(H_0) - \ln(h) = \frac{2KLt}{r_{ce}^2 \ln(r_e / r_{we})}$$

$$r_{we} = r_w \sqrt{K_z / K_r}$$

where

- h is displacement at time t [L]
- H_0 is initial displacement [L]

- K, K_r is radial hydraulic conductivity [L/T]
- K_z is vertical hydraulic conductivity [L/T]
- L is screen length [L]
- n_e is filter pack effective porosity [dimensionless]
- r_c is nominal casing radius [L]
- r_{ce} is effective casing radius (= r_c when well screen is fully submerged) [L]
- r_e is external radius [L]
- r_w is well radius [L]
- r_{we} is equivalent well radius [L]
- t is time [T]

The term $\ln(r_e/r_{we})$ is an empirical quantity that accounts for well geometry (Bouwer and Rice 1976).

Zlotnik (1994) proposed an equivalent well radius (r_{we}) for a partially penetrating well in an anisotropic aquifer. Enter the anisotropy ratio in the aquifer data for the slug test well; the well radius is unchanged when the anisotropy ratio is set to unity (1.0).

- **Assumptions**
  - aquifer has infinite areal extent
  - aquifer is homogeneous and of uniform thickness
  - test well is fully or partially penetrating
  - aquifer is unconfined
  - flow to well is quasi-steady-state (storage is negligible)
  - volume of water, V, is injected into or discharged from the well instantaneously
- **Data Requirements**
  - test well measurements (time and displacement)
  - initial displacement
  - casing radius and well radius
  - depth to top of well screen and screen length
  - saturated thickness

- porosity of gravel pack for well screened across water table (optional)
- hydraulic conductivity anisotropy ratio (for partially penetrating wells)

Estimated Parameters

- K (hydraulic conductivity)
- y0 (intercept of line on y axis)

Curve Matching Tips

- Follow guidelines developed by Butler (1998) for analyzing slug tests.
- Choose Match>Visual to perform visual curve matching using the procedure for straight-line solutions.
- For this solution, visual curve matching is often more effective than automatic matching because you are interested in matching the straight line to a specific range of data that meet the assumptions of the solution. To achieve the same effect with automatic curve matching, it would require the judicious application of weights to ignore observations outside the desired range.
- Choose View>Options and select the **Recommended Head Range** option in the **Plots** tab to superimpose on the plot the head range recommended by Butler (1998) to obtain the most reliable matching results for solutions (assuming a steady-state representation of flow for a slug test).

References

1. Bouwer, H., 1989. The Bouwer and Rice slug test--an update, Ground Water, vol. 27, no. 3, pp. 304-309.
2. Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.
3. Zlotnik, V., 1994. Interpretation of slug and packer tests in anisotropic aquifers, Ground Water, vol. 32, no. 5, pp. 761-766.

Dagan (1978) Solution for a Slug Test in an Unconfined Aquifer Pro

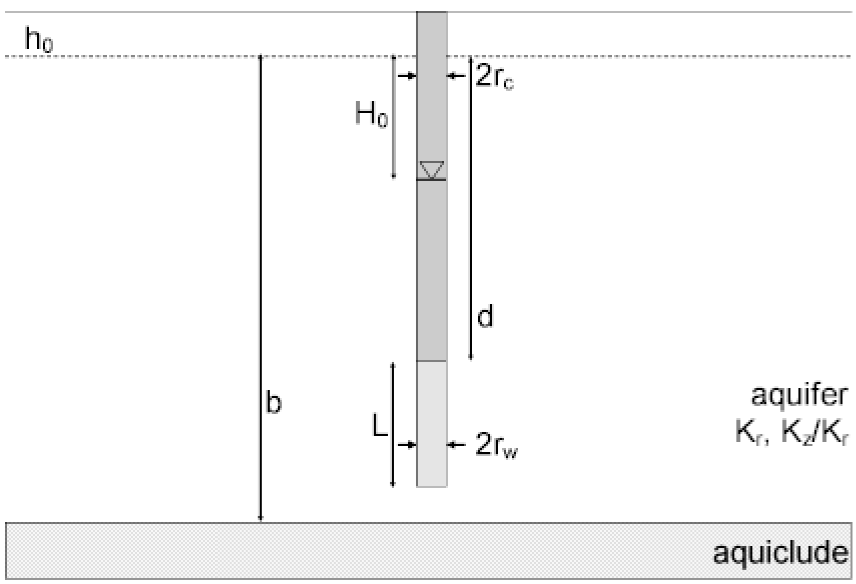
(Match > Solution)

Dagan (1978) developed a semi-analytical method for an overdamped slug test in a well screened across the water table in a homogeneous, anisotropic unconfined aquifer. Like the Bouwer-Rice and Hvorslev models, the Dagan method employs a quasi-steady-state model that ignores elastic storage in the aquifer.

In cases of noninstantaneous test initiation, apply the translation method of Pandit and Miner (1986) prior to analyzing the data.

For wells screened across the water table, you may apply an optional correction for the effective porosity of the filter pack.

- **Illustration**



- **Equations**

Dagan (1978) developed semi-analytical method to predict the water-level response due to the instantaneous injection or withdrawal of water from a well screened across the water table in an unconfined aquifer:

$$\ln\left(\frac{h}{H_0(2L-h/(2L-H_0)}\right) = -\frac{2K_r L t}{r_{ce}^2 / P}$$

$$r_{ce} = \sqrt{r_c^2 + n_e(r_w^2 - r_c^2)}$$

where

- h is displacement at time t [L]
- H_0 is initial displacement [L]

- K, K_r is radial hydraulic conductivity [L/T]
- L is screen length [L]
- n_e is filter pack effective porosity [dimensionless]
- P is dimensionless flow parameter
- r_c is casing radius [L]
- r_{ce} is equivalent casing radius [L]
- r_w is well radius including filter pack [L]
- t is time [T]

The term P is a shape factor that depends on well geometry and hydraulic conductivity anisotropy. Values of P are available in Dagan (1978), Boast and Kirkham (1971) and Butler (1998). AQTESOLV uses a table look-up procedure to find appropriate values of P.

- **Assumptions**
  - aquifer has infinite areal extent
  - aquifer is homogeneous and of uniform thickness
  - test well is partially penetrating
  - aquifer is unconfined
  - flow to well is quasi-steady-state (storage is negligible)
  - volume of water, V, is injected into or discharged from the well instantaneously
- **Data Requirements**
  - test well measurements (time and displacement)
  - initial displacement
  - casing radius and well radius
  - depth to top of well screen and screen length
  - saturated thickness
  - porosity of gravel pack for well screened across water table (optional)
  - hydraulic conductivity anisotropy ratio
- **Estimated Parameters**
  - K (hydraulic conductivity)
  - y0 (intercept of line on y axis)

- **Curve Matching Tips**
  - Follow guidelines developed by Butler (1998) for analyzing slug tests.
  - Choose Match>Visual to perform visual curve matching using the procedure for straight-line solutions.
  - For this solution, visual curve matching is often more effective than automatic matching because you are interested in matching the straight line to a specific range of data that meet the assumptions of the solution. To achieve the same effect with automatic curve matching, it would require the judicious application of weights to ignore observations outside the desired range.
  - Choose View>Options and select the **Recommended Head Range** option in the **Plots** tab to superimpose on the plot the head range recommended by Butler (1998) to obtain the most reliable matching results for solutions (assuming a steady-state representation of flow for a slug test).
- **References**

1. Boast, C.W. and D. Kirkham, 1971. Auger hole seepage theory, Soil Science of America Proceedings, vol. 35, no. 3, pp. 365-373.
2. Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.
3. Butler, J.J., Jr., 1998. The Design, Performance, and Analysis of Slug Tests, Lewis Publishers, Boca Raton, 252p.
4. Dagan, G., 1978. A note on packer, slug, and recovery tests in unconfined aquifers, Water Resources Research, vol. 14, no. 5. pp. 929-934.

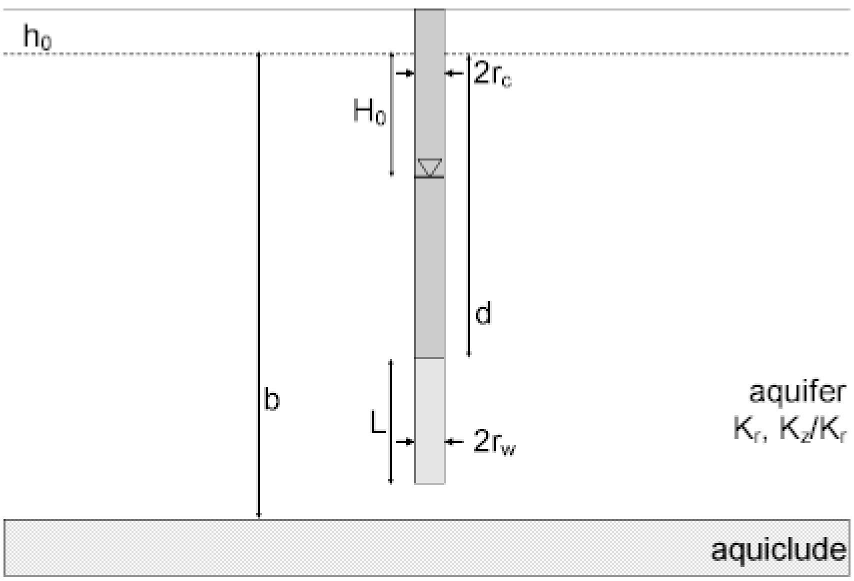
Hvorslev (1951) Solution for a Slug Test in an Unconfined Aquifer

(Match > Solution)

For slug tests in an unconfined aquifer, the preferred quasi-steady-state method is the Bouwer-Rice (1976) solution; however, Bouwer (1989) observed that the water-table boundary in an unconfined aquifer has little effect on slug test response unless the top of the well screen is positioned close to the boundary. Thus, in many cases, we may apply the Hvorslev (1951) solution for confined aquifers to approximate unconfined conditions when the well screen is below the water table.

In cases of noninstantaneous test initiation, apply the translation method of Pandit and Miner (1986) prior to analyzing the data.

- **Illustration**



- **Equations**

  Refer to the equations for the Hvorslev (1951) solution for a confined aquifer.

  For the unconfined variant of the Hvorslev solution, AQTESOLV applies the correction for filter pack porosity for wells screened across the water table. For the confined Hvorslev solution, the filter pack correction is unnecessary.

- **Assumptions**

  - aquifer has infinite areal extent
  - aquifer is homogeneous and of uniform thickness
  - test well is fully or partially penetrating
  - aquifer is confined
  - flow to well is quasi-steady-state (storage is negligible)

- volume of water, V, is injected into or discharged from the well instantaneously

- **Data Requirements**
  - test well measurements (time and displacement)
  - initial displacement
  - casing radius and well radius
  - depth to top of well screen and screen length
  - saturated thickness
  - hydraulic conductivity anisotropy ratio (for partially penetrating wells)

- **Estimated Parameters**
  - K (hydraulic conductivity)
  - y0 (intercept of line on y axis)

- **Curve Matching Tips**
  - Follow guidelines developed by Butler (1998) for analyzing slug tests.
  - Choose Match>Visual to perform visual curve matching using the procedure for straight-line solutions.
  - For this solution, visual curve matching is often more effective than automatic matching because you are interested in matching the straight line to a specific range of data that meet the assumptions of the solution. To achieve the same effect with automatic curve matching, it would require the judicious application of weights to ignore observations outside the desired range.
  - Choose View>Options and select the **Recommended Head Range** option in the **Plots** tab to superimpose on the plot the head range recommended by Butler (1998) to obtain the most reliable matching results for solutions (assuming a steady-state representation of flow for a slug test).

- **References**

1. Bouwer, H., 1989. The Bouwer and Rice slug test--an update, Ground Water, vol. 27, no. 3, pp. 304-309.
2. Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

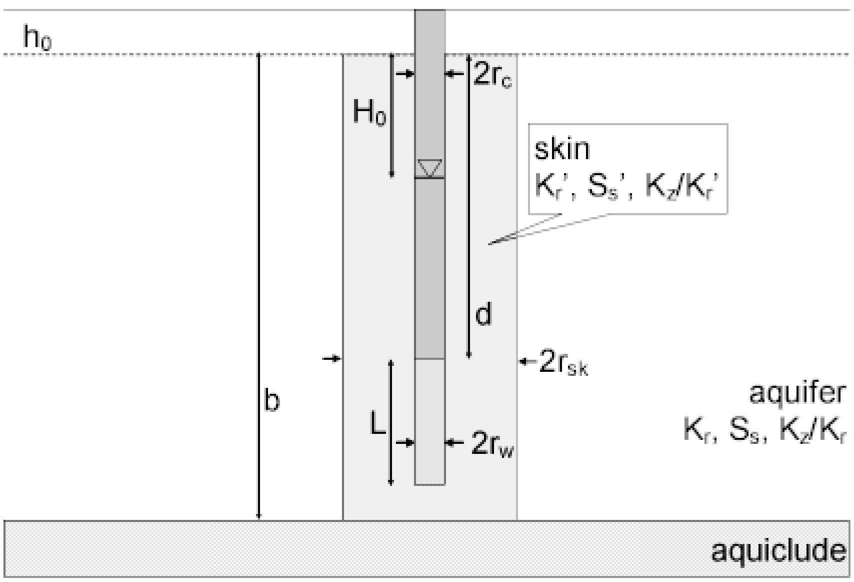
Hyder et al. (1994) Solution for a Slug Test in an Unconfined Aquifer (KGS Model) Pro

(Match > Solution)

Hyder et al. (1994) developed a fully transient model, also known as the **KGS Model**, for an overdamped slug test in an unconfined aquifer for fully and partially penetrating wells. The solution simulates water-level response at the test and observation wells and includes a skin zone of finite thickness enveloping the test well. The KGS Model allows you to analyze data from multiwell slug tests.

When you choose a solution, AQTESOLV provides two configurations for simulating a slug test with the KGS Model. One configuration omits the well skin and the other includes it.

- **Illustration**



- **Equations**

Hyder et al. (1994) derived an analytical solution, also known as the KGS Model, describing the water-level response due to the instantaneous injection or withdrawal of water from a fully or partially penetrating well in an unconfined aquifer. The equation for the Laplace transform solution for head in the test well is as follows:

$$\bar{h} = \frac{(\gamma/2)\Omega^*}{(1+(\gamma/2)p\Omega^*)}$$

$$\alpha = \frac{2r_2^2 S_{s2} L}{r_c^2}$$

$$\gamma = K_{r2}/K_{r1}$$

$$\Omega^* = \int_{\varsigma}^{\varsigma+1} (F_s^{-1}[F_s(\varpi^*)f_1])d\eta$$

$$f_1 = \frac{[\Delta_2 K_0(\upsilon_1) - \Delta_1 I_0(\upsilon_1)]}{\upsilon_1[\Delta_2 K_1(\upsilon_1) + \Delta_1 I_1(\upsilon_1)]}$$

$$\eta = z / L$$

$$\zeta = d / L$$

$$\upsilon_i = (\psi_i^2 \varpi^2 + R_i^2 p)^{1/2}$$

$$\psi_i = (A_i / a^2)^{1/2}$$

$$A_i = K_{zi} / K_{ri}$$

$$a = L / r_w$$

$$R_1 = \gamma\alpha / 2\lambda$$

$$R_2 = \alpha / 2$$

$$\lambda = S_{s2} / S_{s1}$$

$$\Delta_1 = K_0(\upsilon_1 \xi_{sk}) K_1(\upsilon_2 \xi_{sk}) - \frac{N}{\gamma} K_0(\upsilon_2 \xi_{sk}) K_1(\upsilon_1 \xi_{sk})$$

$$\Delta_2 = I_0(\upsilon_1 \xi_{sk}) K_1(\upsilon_2 \xi_{sk}) + \frac{N}{\gamma} K_0(\upsilon_2 \xi_{sk}) I_1(\upsilon_1 \xi_{sk})$$

$$N = \upsilon_1 / \upsilon_2$$

$$\xi = r_{sk} / r_w$$

$$F_s(\varpi^*) = \text{modified finite fourier sine transform of } B(z)$$

$$F_s^{-1} = \text{inverse modified finite fourier sine transform}$$

$$B(z) = \begin{cases} 0, z < d, z > L + d \\ 1, \textit{otherwise} \end{cases}$$

where

- the subscript i = 1, 2 refers to the aquifer and well skin, respectively
- d is depth to top of well screen [L]
- I_i is modified Bessel function of first kind, order i
- K_r is radial hydraulic conductivity [L/T]
- K_z is vertical hydraulic conductivity [L/T]

- K_i is modified Bessel function of second kind, order i
- L is screen length [L]
- p is the Laplace transform variable
- r is radial distance [L]
- r_c is casing radius [L]
- r_{sk} is well skin radius [L]
- r_w is well radius [L]
- S_s is specific storage [1/L]
- z is depth below top of aquifer [L]

◦ **Assumptions**

- aquifer has infinite areal extent
- aquifer is homogeneous and of uniform thickness
- aquifer potentiometric surface is initially horizontal
- test and observation wells are fully or partially penetrating
- aquifer is unconfined
- flow is unsteady
- water is released instantaneously from storage with decline of hydraulic head
- a volume of water, V, is injected into or discharged from the well instantaneously

◦ **Data Requirements**

- test and observation well measurements (time and displacement)
- initial displacement
- casing radius, well radius and outer radius of well skin for test well
- saturated thickness
- well depth and screen length

◦ **Estimated Parameters**

- Kr (radial hydraulic conductivity in aquifer)
- Ss (specific storage in aquifer)
- Kz/Kr (anisotropy ratio in aquifer)

- Kr' (radial hydraulic conductivity in skin)
- Ss' (specific storage in skin)
- Kz/Kr' (anisotropy ratio in skin)

○ **Curve Matching Tips**

- Follow guidelines developed by Butler (1998) for analyzing slug tests.
- Choose Match>Visual to perform visual curve matching using the procedure for type-curve solutions.
- Select values of Ss and Kz/Kr from the **Family** and **Curve** drop-down lists on the toolbar.
- Use parameter tweaking to perform visual curve matching and sensitivity analysis.

○ **References**

1. Hyder, Z, J.J. Butler, Jr., C.D. McElwee and W. Liu, 1994. Slug tests in partially penetrating wells, Water Resources Research, vol. 30, no. 11, pp. 2945-2957.

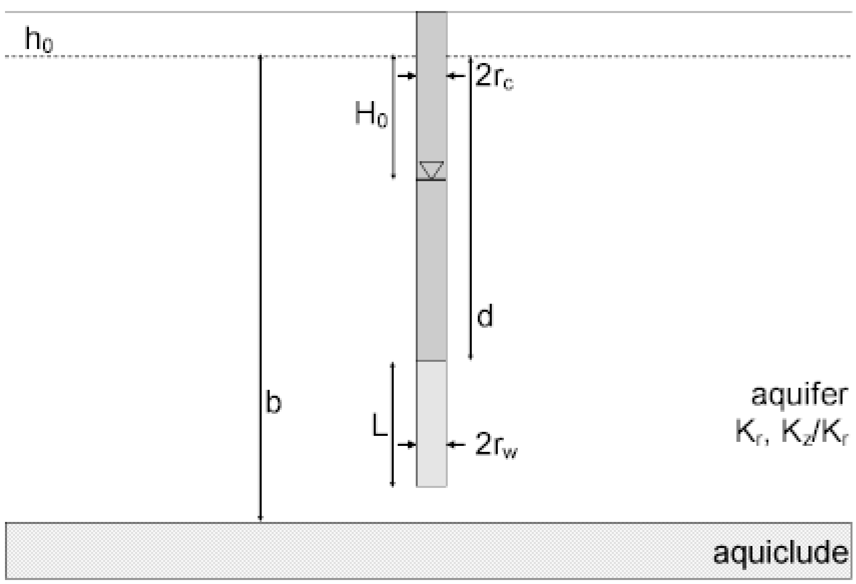
Springer-Gelhar (1991) Solution for a Slug Test in an Unconfined Aquifer

(Match > Solution)

Springer and Gelhar (1991) extended the Bouwer-Rice (1976) solution for a slug test in a homogeneous, anisotropic unconfined aquifer to include inertial effects in the test well. The solution accounts for oscillatory water-level response sometimes observed in aquifers of high hydraulic conductivity. Based on the work of Butler (2002), we also incorporate frictional well loss in small-diameter wells.

The Springer-Gelhar solution predicts the theoretical change in water level in the test well; however, McElwee (2001) and Zurbuchen et al. (2002) have noted that transducer readings vary with depth and thus may not accurately measure the water-level position. Butler et al. (2003) recommend placing the transducer close to the static water surface in the well to avoid this problem.

- **Illustration**



- **Equations**

The Springer-Gelhar (1991) solution accounts for underdamped (oscillatory) water-level response sometimes observed in aquifers of high hydraulic conductivity:

$$w_D(t_D) = \begin{cases} e^{-C_D t_D}\left(\cos(\omega_D t_D) + \dfrac{C_D}{\omega_D}\sin(\omega_D t_D)\right), & C_D < 1 \\ e^{-t_D}(1+t_D), & C_D = 1 \\ -\left(\dfrac{1}{\omega_D^+ - \omega_D^-}\right)\left(\omega_D^- e^{\omega_D^+ t_D} - \omega_D^+ e^{\omega_D^- t_D}\right), & C_D > 1 \end{cases}$$

$$w_D = s / H_0$$

$$t_D = t\sqrt{g / L_e}$$

$$C_D = \sqrt{g / L_e}\,\frac{r_c^2 \ln(r_e / r_w)}{4K_r L}$$

$$\omega_D = \sqrt{1 - C_D}$$

$$\omega_D^{\pm} = -C_D \pm \omega_D$$

$$\psi = \frac{\sqrt{K_z / K_r}}{L / r_w}$$

where

- g is gravitational acceleration [L/T^2]
- H_0 is initial displacement [L]
- K_r is radial hydraulic conductivity [L/T]
- K_z is vertical hydraulic conductivity [L/T]
- L is screen length [L]
- L_e is effective water column length [L]
- r_c is casing radius [L]
- r_w is well radius [L]
- s is displacement [L]
- t is time [T]

The term $\ln(r_e/r_w)$ is an empirical quantity that accounts for well geometry (Bouwer and Rice 1976).

In the foregoing equations, the dimensionless damping factor, C_D, is termed critically damped when its value equals 1. Certain publications (e.g., Butler 1998) use an alternate convention in which the equations are critically damped when C_D equals 2.

Butler (2002) modified the definition of C_D to include frictional well loss:

$$C_D = \sqrt{g / L_e}\left(\frac{r_c^2 \ln(r_e / r_w)}{4K_r L} + \frac{4\upsilon\left(\ell + \frac{r_c^2}{r_w^2}\frac{L}{2}\right)}{r_c^2 g}\right)$$

where

- ℓ is length of water column above top of well screen [L]
- ν is kinematic viscosity [L^2/T]

- **Assumptions**
  - aquifer has infinite areal extent
  - aquifer is homogeneous and of uniform thickness
  - test well is fully or partially penetrating
  - aquifer is unconfined
  - flow is quasi-steady state
  - volume of water, V, is injected into or discharged from the well instantaneously
- **Data Requirements**
  - test well measurements (time and displacement)
  - initial displacement
  - static water column height
  - casing radius and well radius
  - depth to top of well screen and screen length
  - saturated thickness
  - hydraulic conductivity anisotropy ratio
  - kinematic viscosity of water (optional)
  - gravitational acceleration constant (optional)
- **Estimated Parameters**
  - K (hydraulic conductivity)
  - Le (effective water column length in test well)

  For reference, AQTESOLV also displays the parameter L (theoretical effective water column length) determined from well geometry data. One normally expects Le to be close to the value of L.
- **Curve Matching Tips**
  - Choose Match>Visual to perform visual curve matching using the procedure for type-curve solutions. Move the mouse up and down to adjust the amplitude of the curve. Move the mouse left and right to adjust the period.
  - Select values of Le from the **Family** and **Curve** drop-down lists on the toolbar.
  - Use parameter tweaking to perform visual curve matching and sensitivity analysis.

- When performing automatic curve matching, save time by setting weights to zero for any observations that have recovered to static near the end of the test.

- Choose View>Options to change the critically damped value of dimensionless damping factor, C(D) (i.e., 1 or 2).

- **References**

1. Springer, R.K. and L.W. Gelhar, 1991. Characterization of large-scale aquifer heterogeneity in glacial outwash by analysis of slug tests with oscillatory response, Cape Cod, Massachusetts, U.S. Geol. Surv. Water Res. Invest. Rep. 91-4034, pp. 36-40.

2. Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

3. Butler, J.J., Jr., 1998. The Design, Performance, and Analysis of Slug Tests, Lewis Publishers, Boca Raton, 252p.

4. Butler, J.J., Jr., 2002. A simple correction for slug tests in small-diameter wells, Ground Water, vol. 40, no. 3, pp. 303-307.

5. Butler, J.J., Jr., Garnett, E.J. and J.M. Healey, 2003. Analysis of slug tests in formations of high hydraulic conductivity, Ground Water, vol. 41, no. 5, pp. 620-630.

6. McElwee, C.D., Butler, J.J., Jr. and G.C. Bohling, 1992. Nonlinear analysis of slug tests in highly permeable aquifers using a Hvorslev-type approach, Kansas Geol. Survey Open-File Report 92-39.

7. Zlotnik, V.A. and V.L. McGuire, 1998. Multi-level slug tests in highly permeable formations: 1. Modifications of the Springer-Gelhar (SG) model, Jour. of Hydrol., no. 204, pp. 271-282.

8. Zurbuchen, B. R., V.A. Zlotnik and J.J. Butler, Jr., 2002. Dynamic interpretation of slug tests in highly permeable aquifers, Water Resources Research, vol. 38, no. 3., 1025, doi:10.1029/2001WRR000354.

Attachment 5:
Hydraulic Conductivity Tests
Graphical Solutions and Statistical Evaluation
(included on CD)

Contents

Well ID	Test Type	Trial	Bouwer-Rice (1976)	Hvorslev (1957)	Hyder et al. (KGS) (1994)	Dagan (1978)	Springer-Gelhar (1991)	Total No. pages
DMMW001	Falling Head	1	●	●	●	●	●	5
		2	●	●	●	●	●	5
	Rising Head	1	●	●	●	●	●	5
		2	●	●	●	●	●	5
DMMW002	Falling Head	1	●	●	●	●	●	5
		2	●	●	●	●	●	5
	Rising Head	1	●	●	●	●	●	5
		2	●	●	●	●	●	5
DMMW003	Falling Head	1	●	●	●	●	●	5
		2	●	●	●	●	●	5
	Rising Head	1	●	●	●	●	●	5
		2	●	●	●	●	●	5

Note: ● = graphical solution included in this attachment

TABLE 3

PRECISION BASED ON RELATIVE STANDARD DEVIATION (RSD)
SHERWIN-WILLIAMS
DUMP SITE
Gibbsboro - NJ

Well No.	Statistic	Bouwer & Rice (1976)	Hvorslev (1951)	Hyder et al. (KGS) (1994)	Dagan (1978)	Springer-Gelhar (1991)
DMMW0001	N	4	4	4	4	4
	Median (ft/day)	4.772	7.963	1.482	6.389	1.601
	Standard Deviation	2.248	3.247	0.476	2.058	0.711
	RSD	47.1%	40.8%	32.1%	32.2%	44.4%
DMMW0002	N	4	4	4	4	4
	Median (ft/day)	0.740	1.113	0.754	0.874	0.645
	Standard Deviation	0.026	0.095	0.038	0.047	0.044
	RSD	3.5%	8.5%	5.1%	5.4%	6.7%
DMMW0003	N	4	4	4	4	4
	Median (ft/day)	1.141	1.731	1.400	1.343	1.179
	Standard Deviation	0.281	0.540	0.438	0.415	0.327
	RSD	24.6%	31.2%	31.3%	30.9%	27.7%

Precision Rating: Based on RSD (Relative Standard Deviation)

High:	RSD >20%
Moderate:	RSD 10% - 20%
Low:	RSD 5% - 10%
Very Low:	RSD 0% - 5%

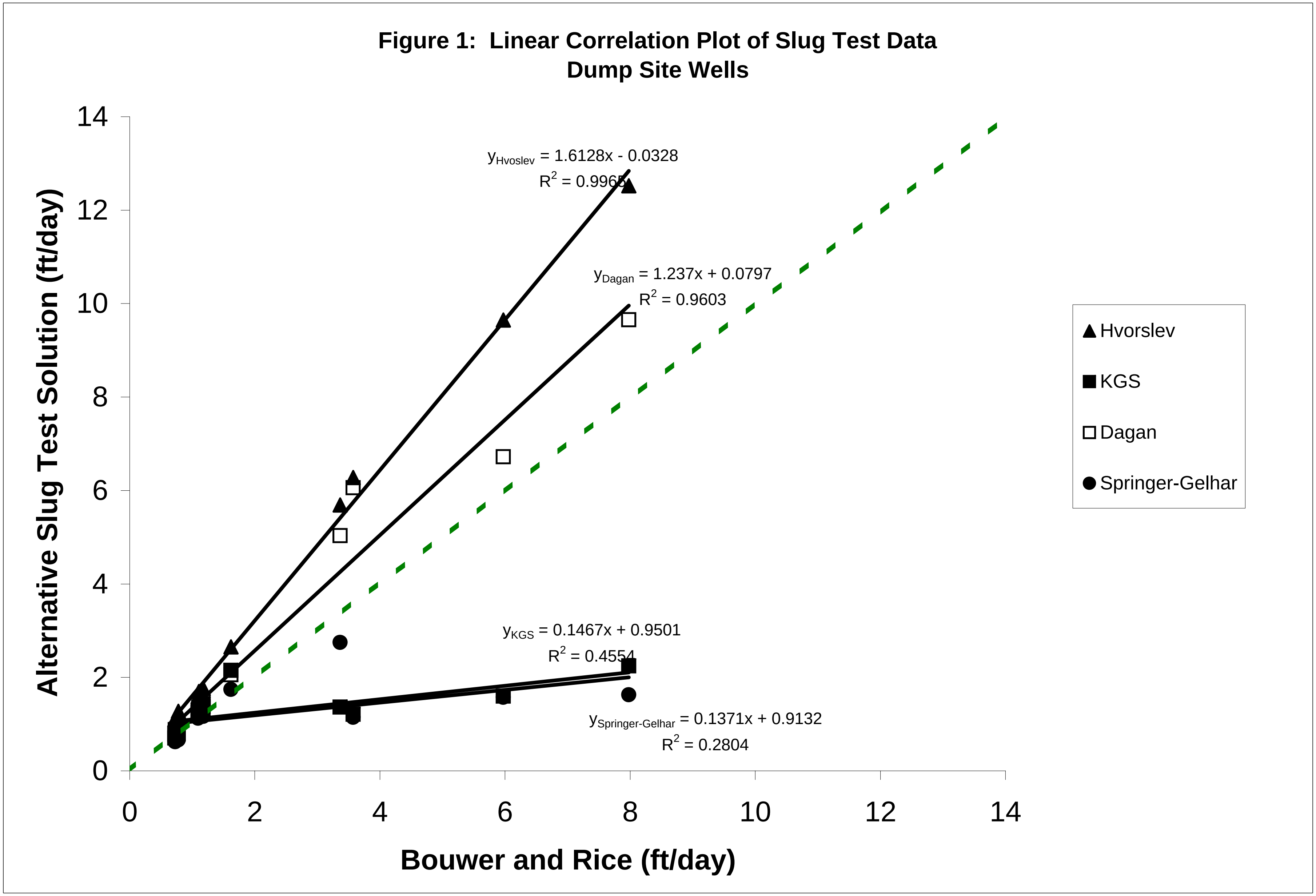
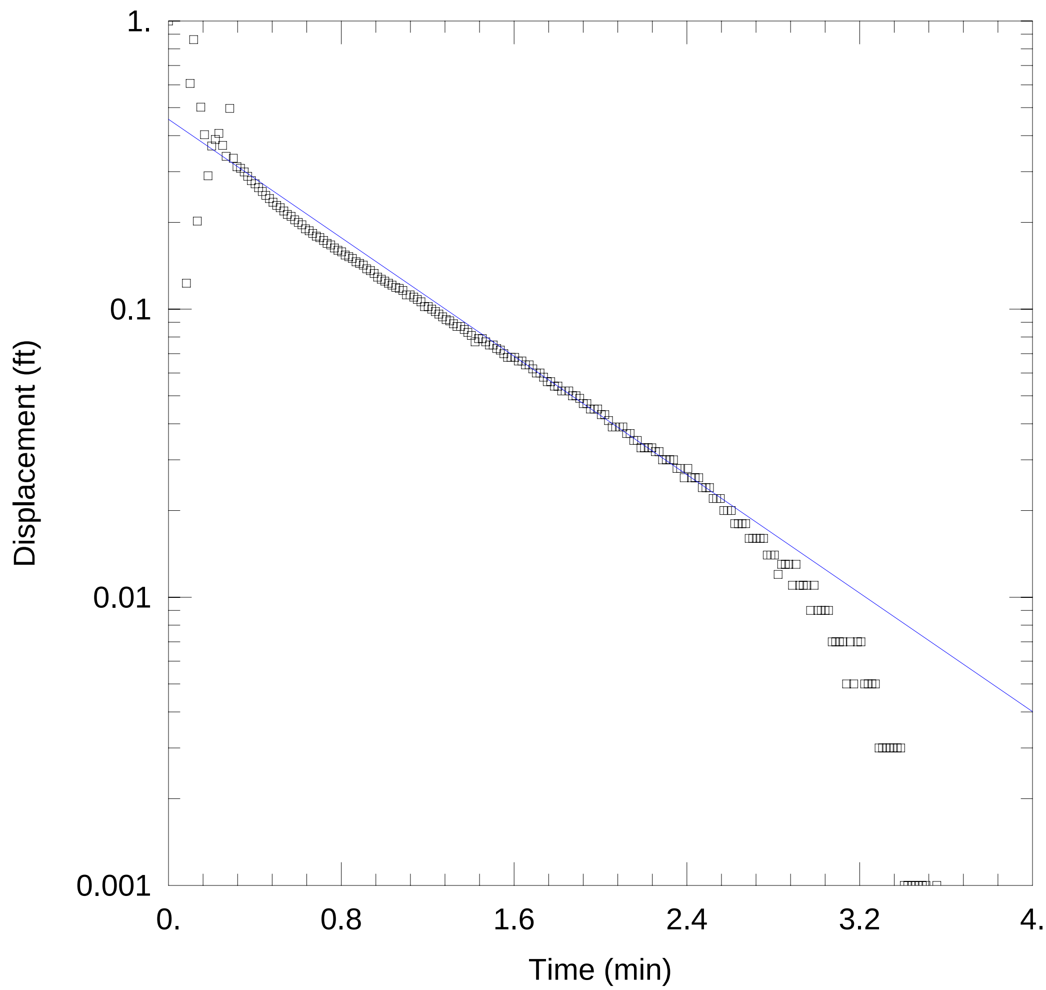


Figure 1: Linear Correlation Plot of Slug Test Data
Dump Site Wells
$y_{Hvoslev}$ = 1.6128x - 0.0328
R^2 = 0.9965
y_{Dagan} = 1.237x + 0.0797
R^2 = 0.9603
y_{KGS} = 0.1467x + 0.9501
R^2 = 0.4554
$y_{Springer-Gelhar}$ = 0.1371x + 0.9132
R^2 = 0.2804
Hvorslev
KGS
Dagan
Springer-Gelhar
Alternative Slug Test Solution (ft/day)
Bouwer and Rice (ft/day)
0
2
4
6
8
10
12
14



DMMW0001 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW1-in1BR.aqt
Date: 09/15/08 Time: 13:28:09

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Willliams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

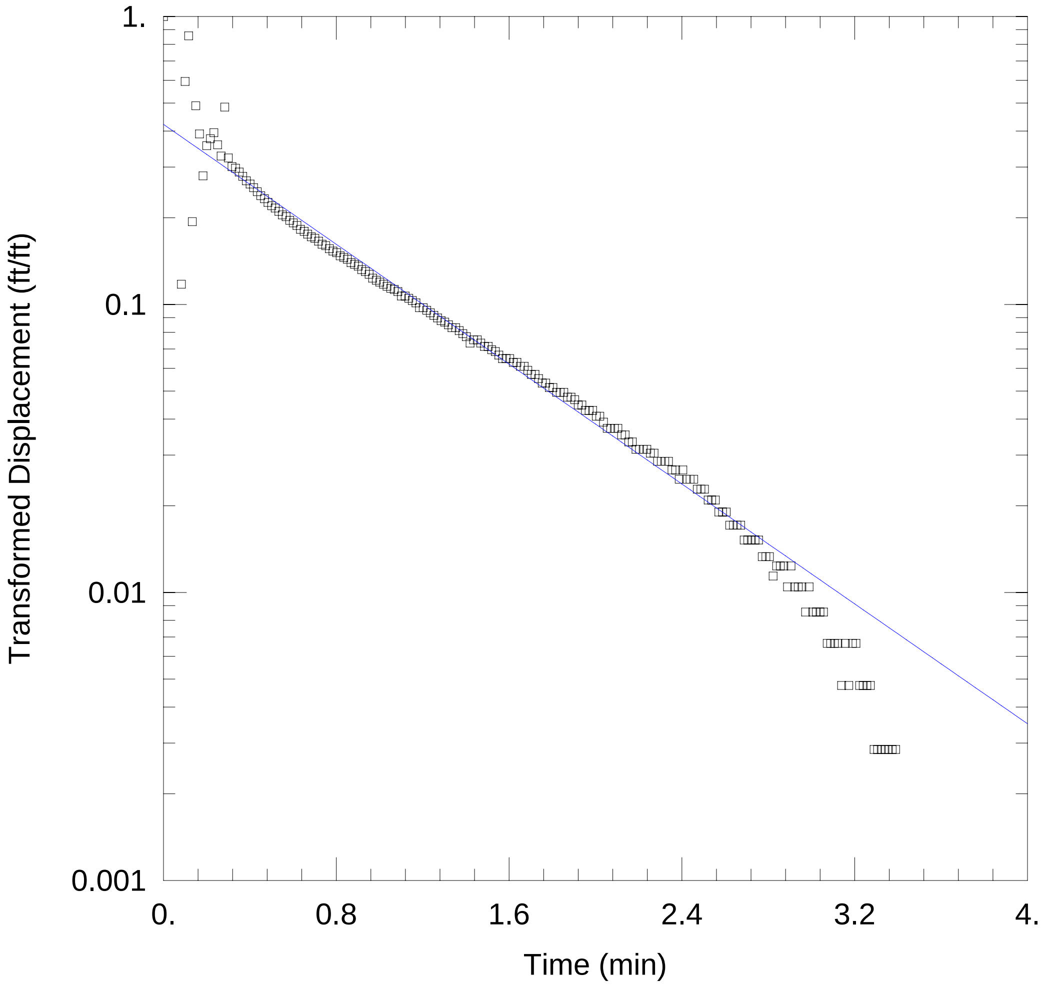
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 7.98 ft/day y0 = 0.4558 ft



DMMW0001 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW1-in1DGN.aqt
Date: 09/15/08 Time: 13:29:20

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Willliams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

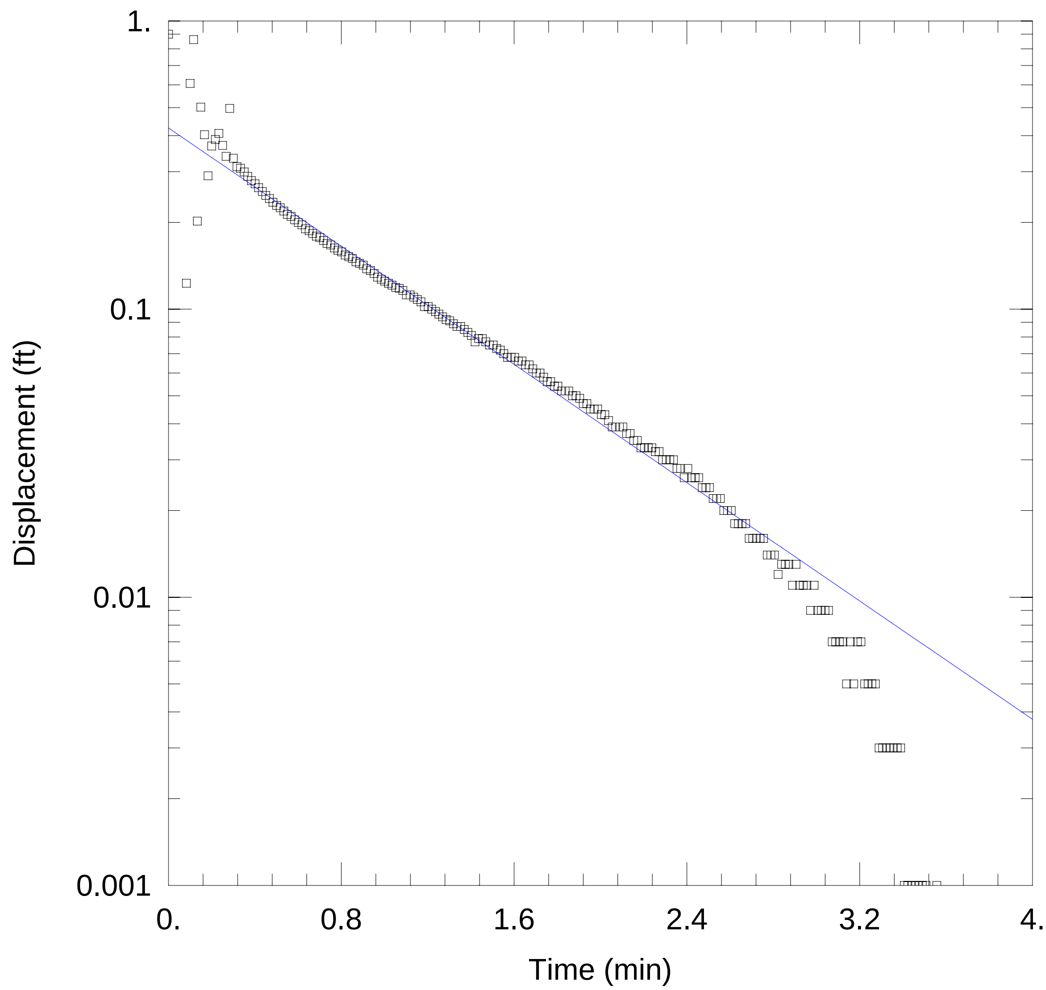
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan

K = 9.653 ft/day
y0 = 0.4343 ft



DMMW0001 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW1-in1HV.aqt
Date: 09/15/08 Time: 13:29:39

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Willliams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

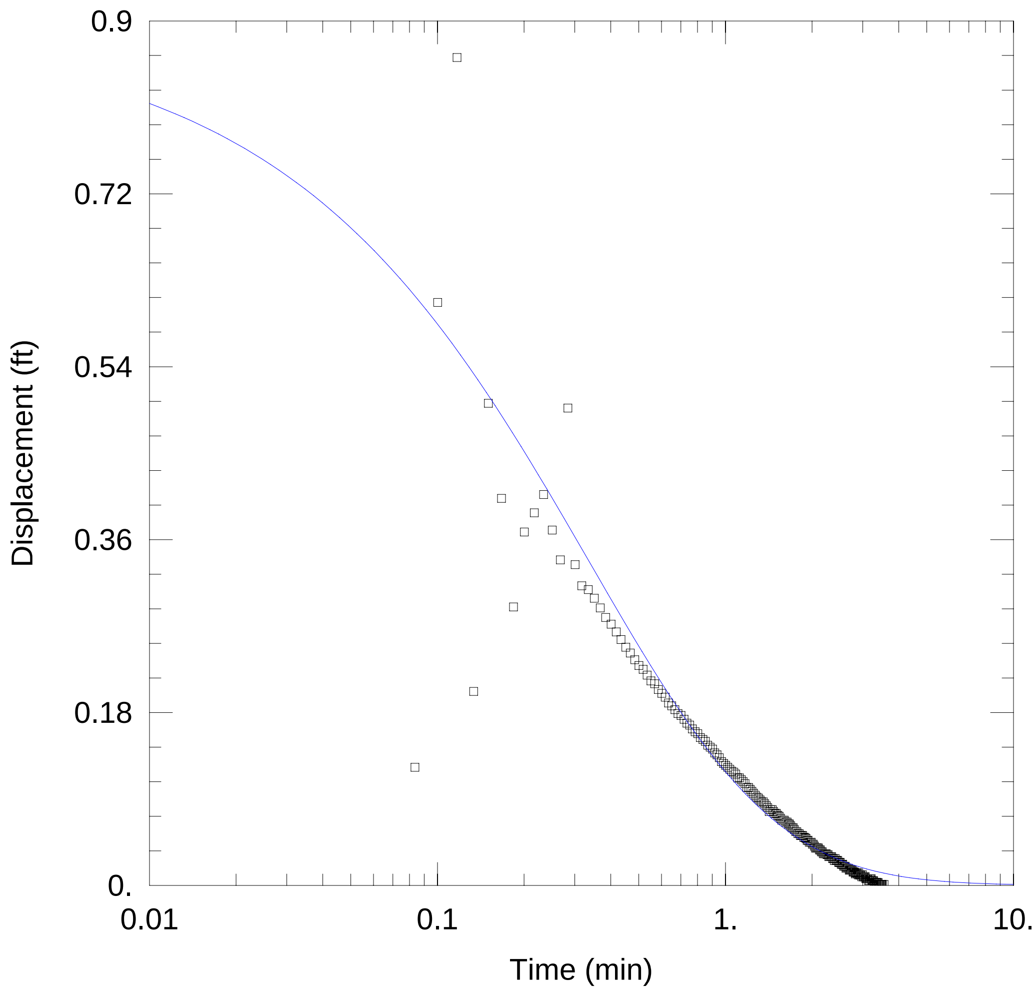
WELL DATA (DMMW0001)

Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 12.52 ft/day y0 = 0.4253 ft



DMMW0001 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW1-in1KGS.aqt
Date: 09/15/08 Time: 13:30:24

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Willliams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMMW0001)

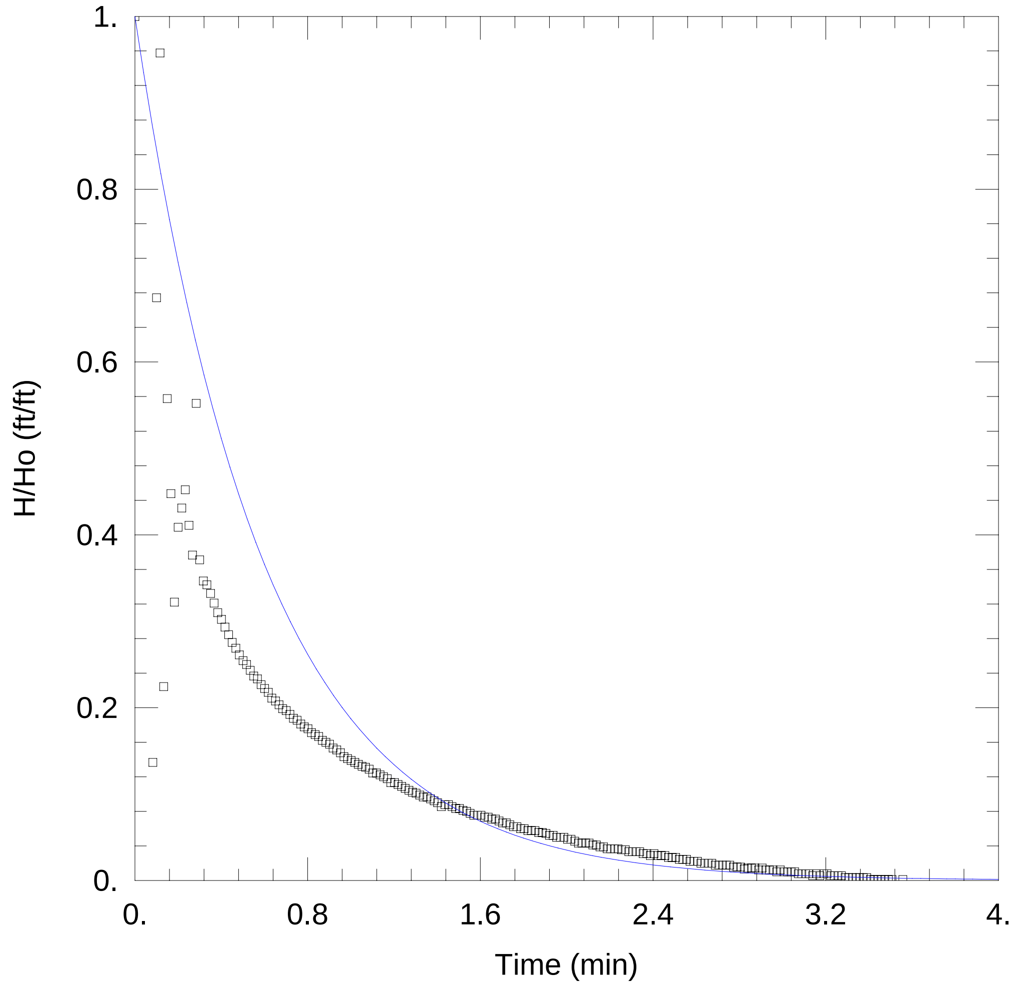
Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft

Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.243 ft/day
Kz/Kr = 1.
Ss = 0.0002387 ft^{-1}



DMMW0001 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW1-in1SG.aqt
Date: 09/15/08 Time: 13:30:44

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Willliams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

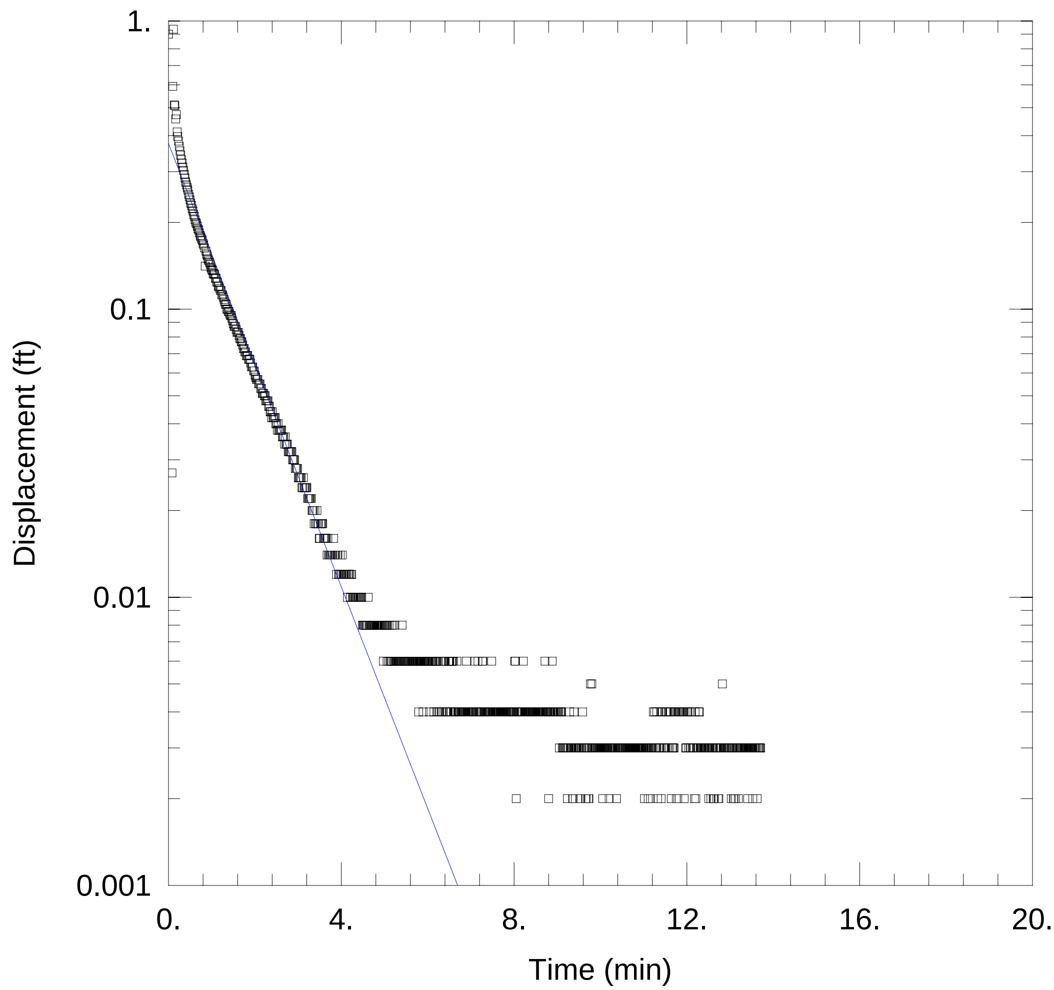
WELL DATA (DMMW0001)

Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 1.627 ft/day
Le = 2.291 ft



DMMW0001 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW1-in2BR.aqt
Date: 09/15/08 Time: 13:31:03

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (DMMW0001)

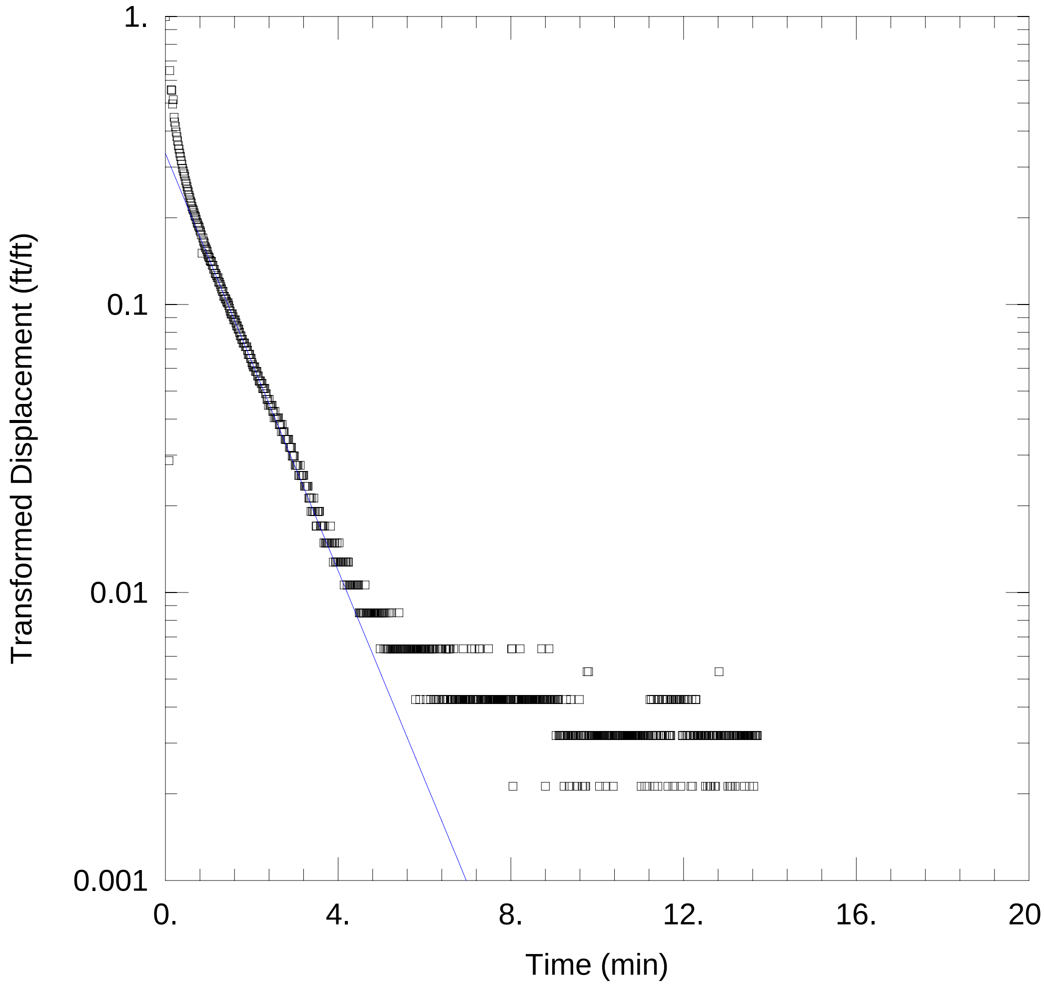
Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft

Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.973 ft/day y0 = 0.3754 ft



DMMW0001 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW1-in2DGN.aqt
Date: 09/15/08 Time: 13:31:21

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

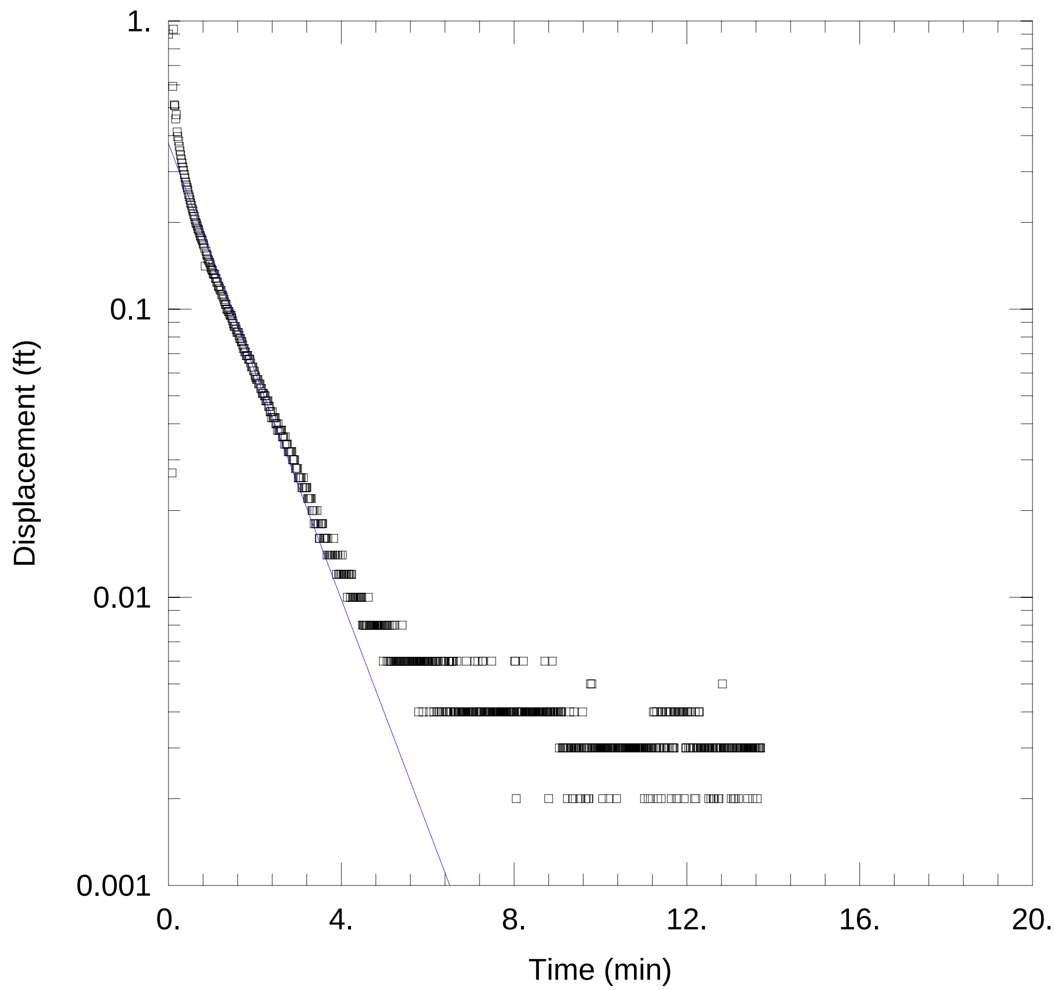
WELL DATA (DMMW0001)

Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan

K = 6.719 ft/day
y0 = 0.31 ft



DMMW0001 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW1-in2HV.aqt
Date: 09/15/08 Time: 13:31:40

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (DMMW0001)

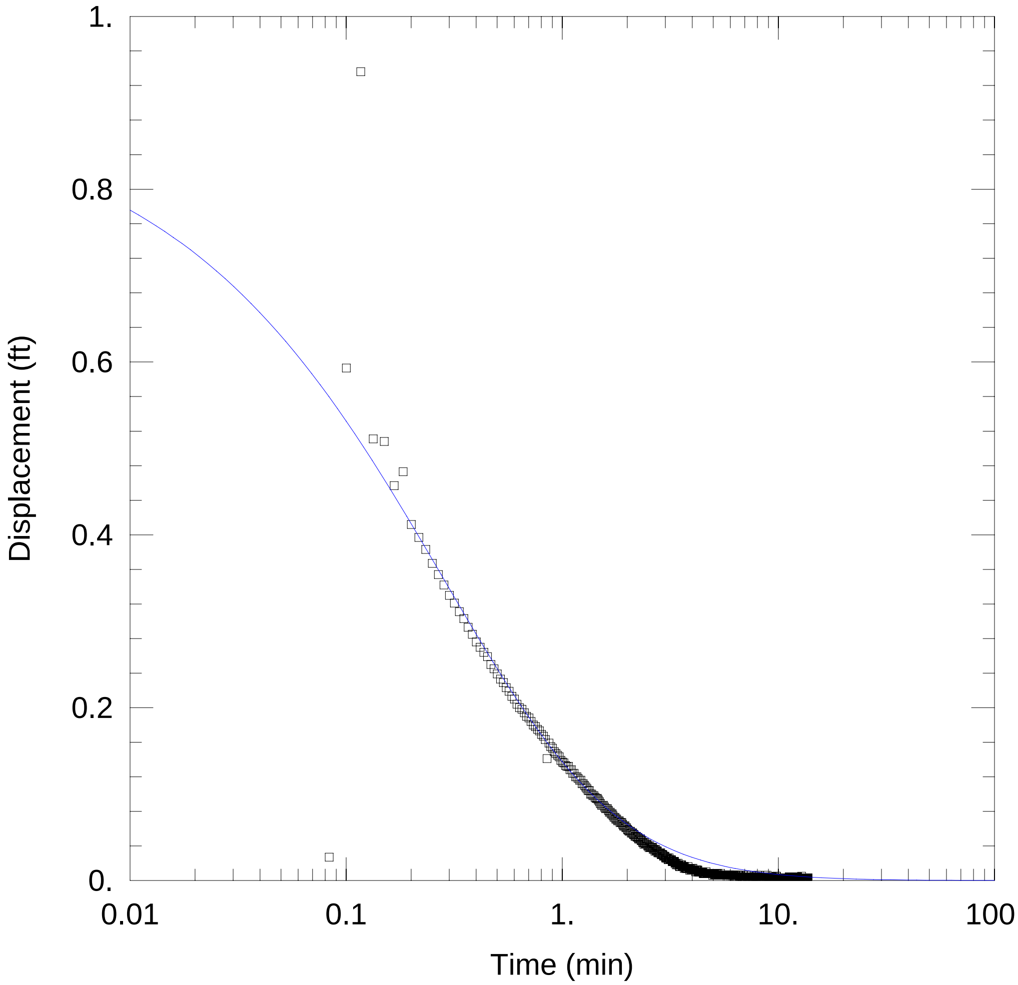
Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft

Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 9.649 ft/day y0 = 0.3754 ft



DMMW0001 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW1-in2KGS.aqt
Date: 09/15/08
Time: 13:31:58

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMMW0001)

Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft

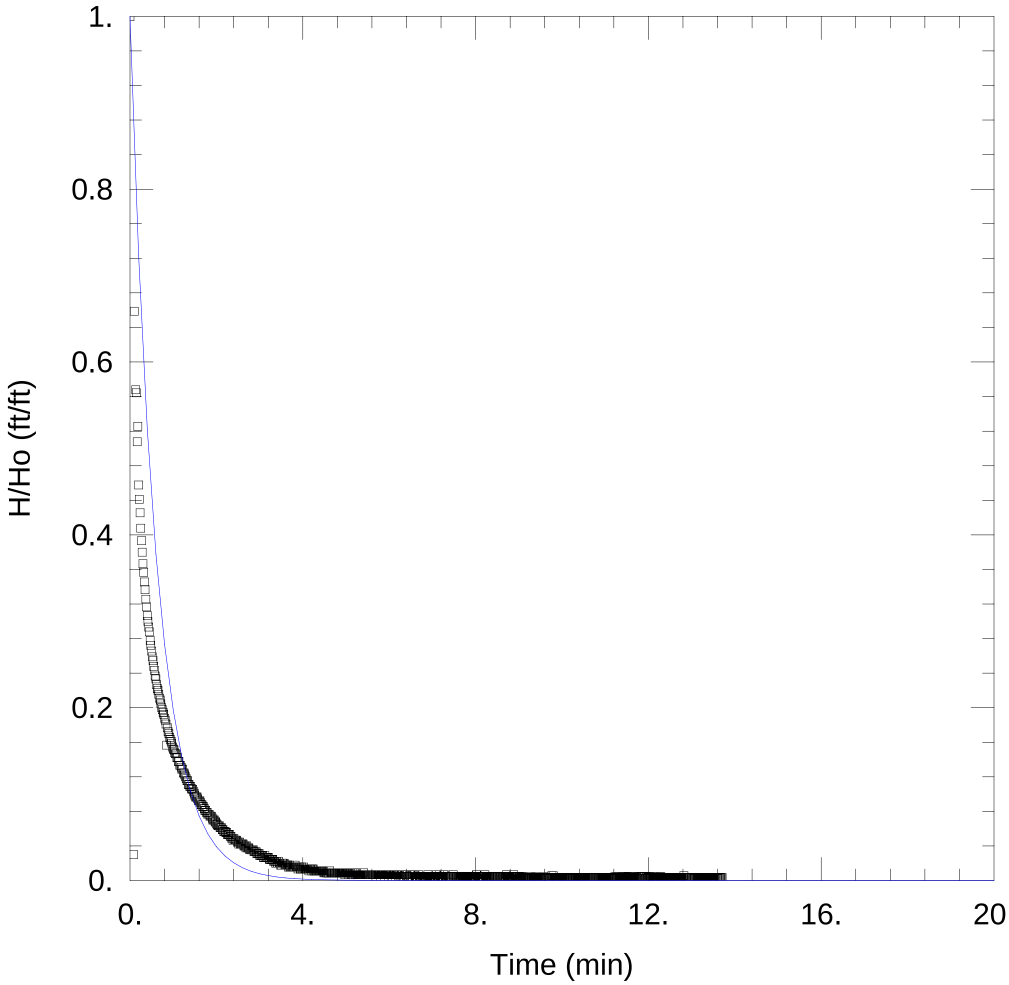
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 1.597 ft/day
Kz/Kr = 1.

Ss = 0.001 ft^{-1}



DMMW0001 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW1-in2SG.aqt
Date: 09/15/08 Time: 13:32:52

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

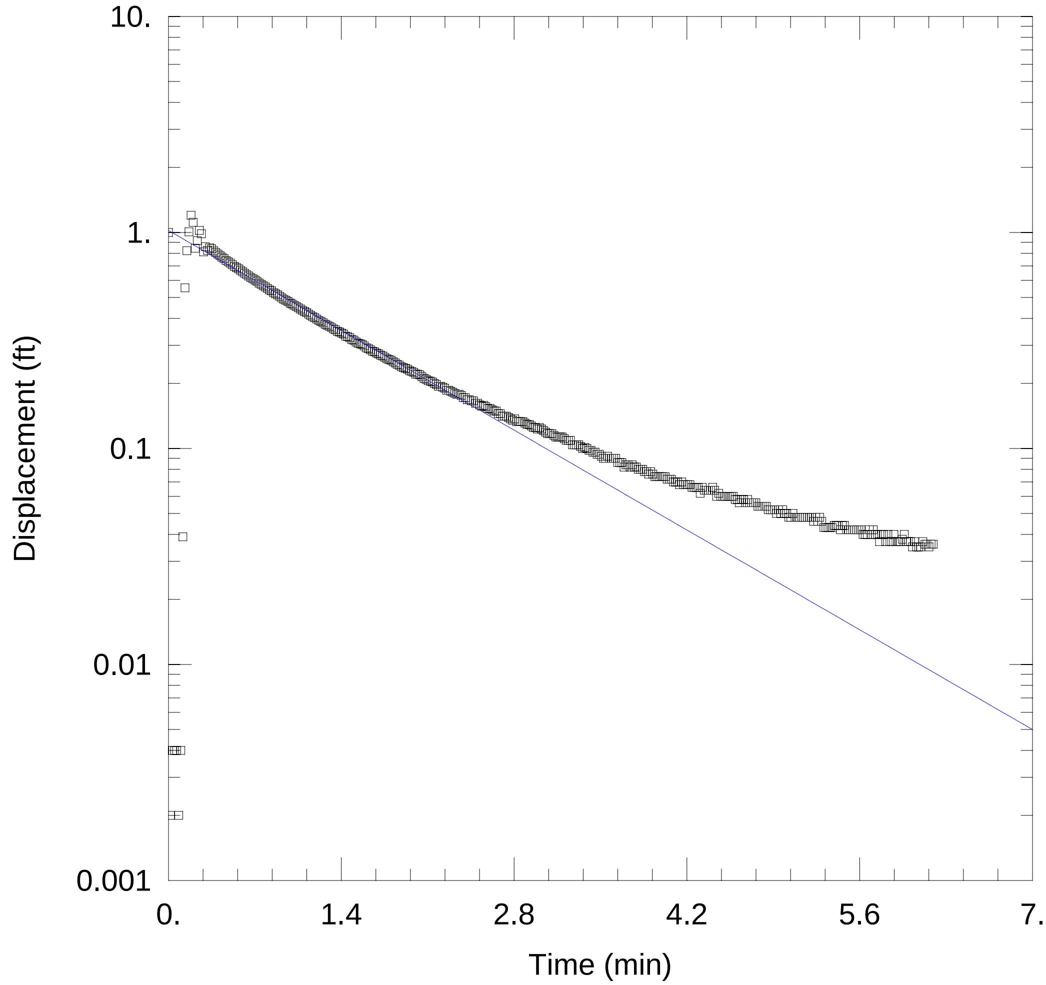
WELL DATA (DMMW0001)

Initial Displacement: 0.9 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 1.575 ft/day
Le = 5. ft



DMMW0002 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW2-in1BR.aqt
Date: 10/28/08 Time: 12:43:12

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

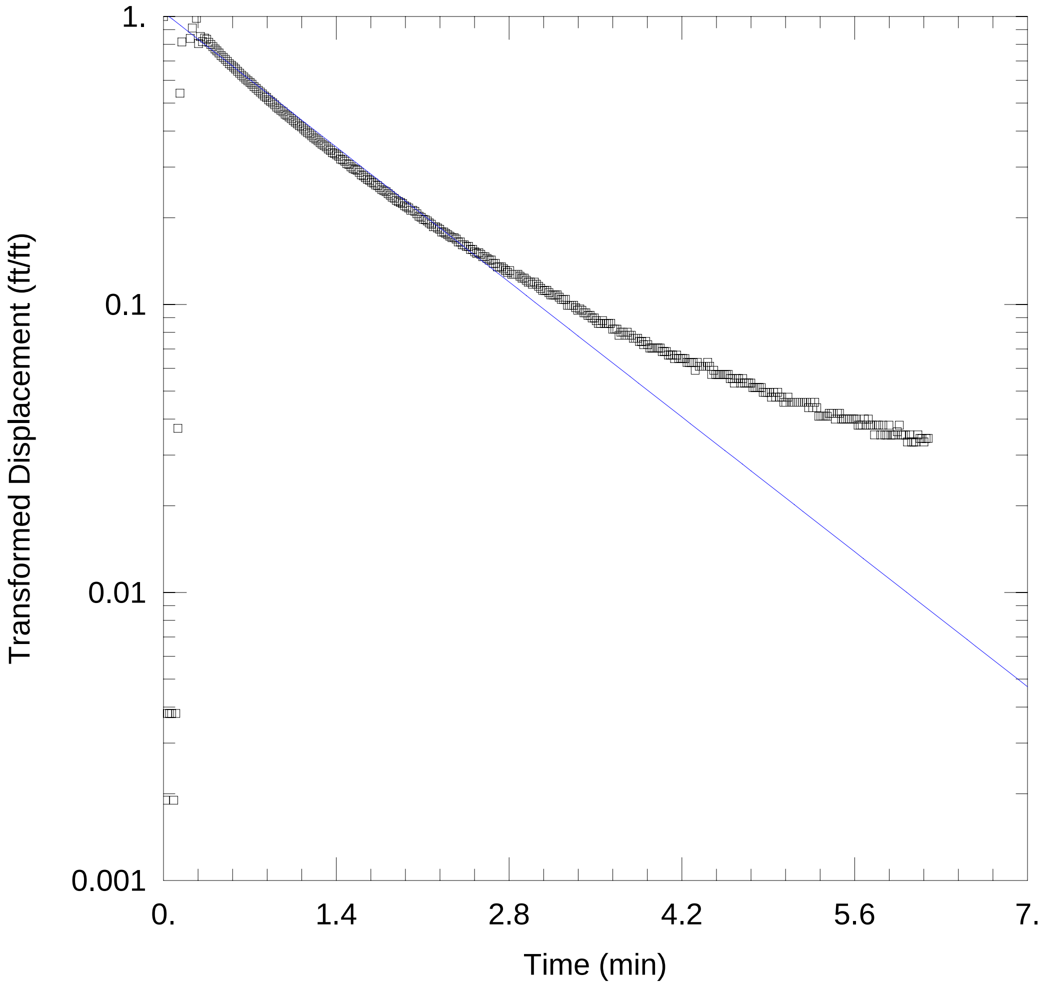
WELL DATA (DMMW0002)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.7523 ft/day y0 = 1.021 ft



DMMW0002 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW2-in1DGN.aqt
Date: 09/15/08 Time: 13:33:30

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

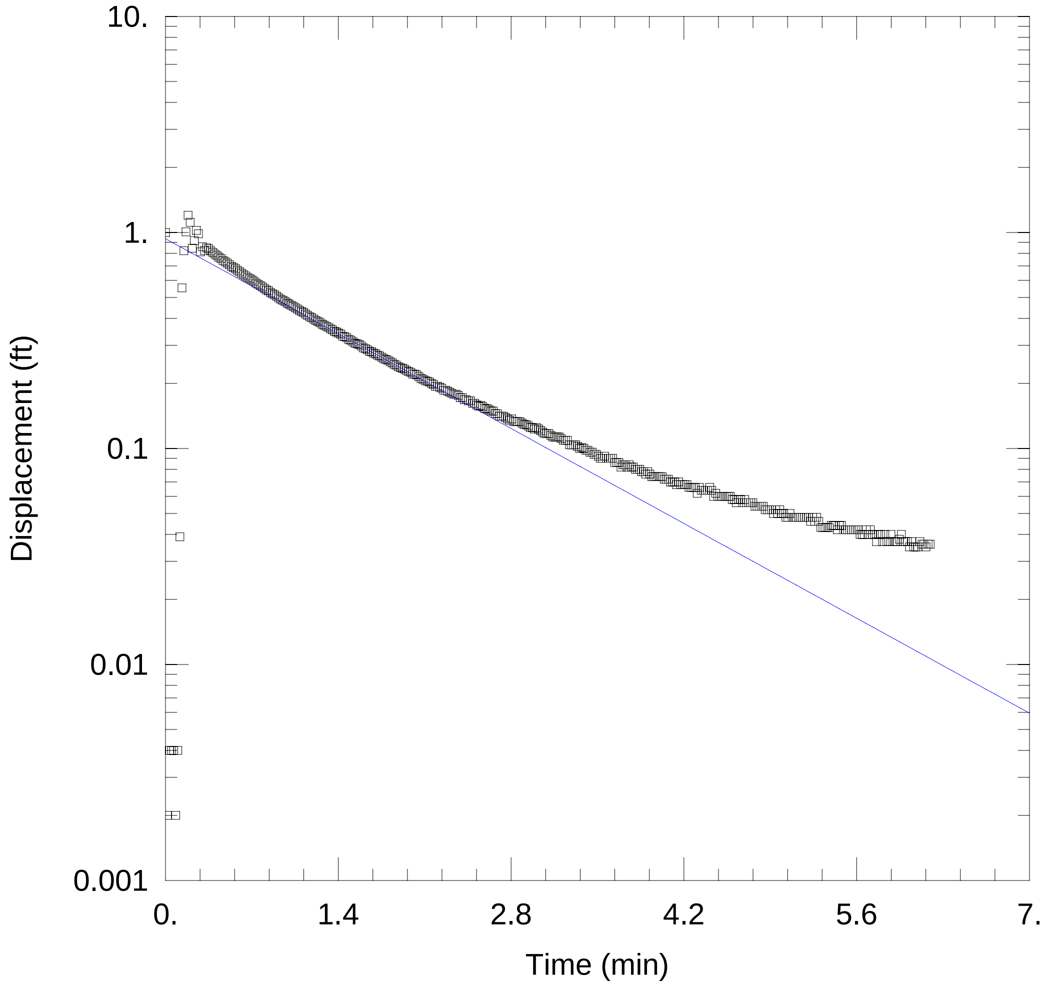
WELL DATA (DMMW0002)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 0.8938 ft/day y0 = 1.033 ft



DMMW0002 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW2-in1HV.aqt
Date: 09/15/08 Time: 13:33:55

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

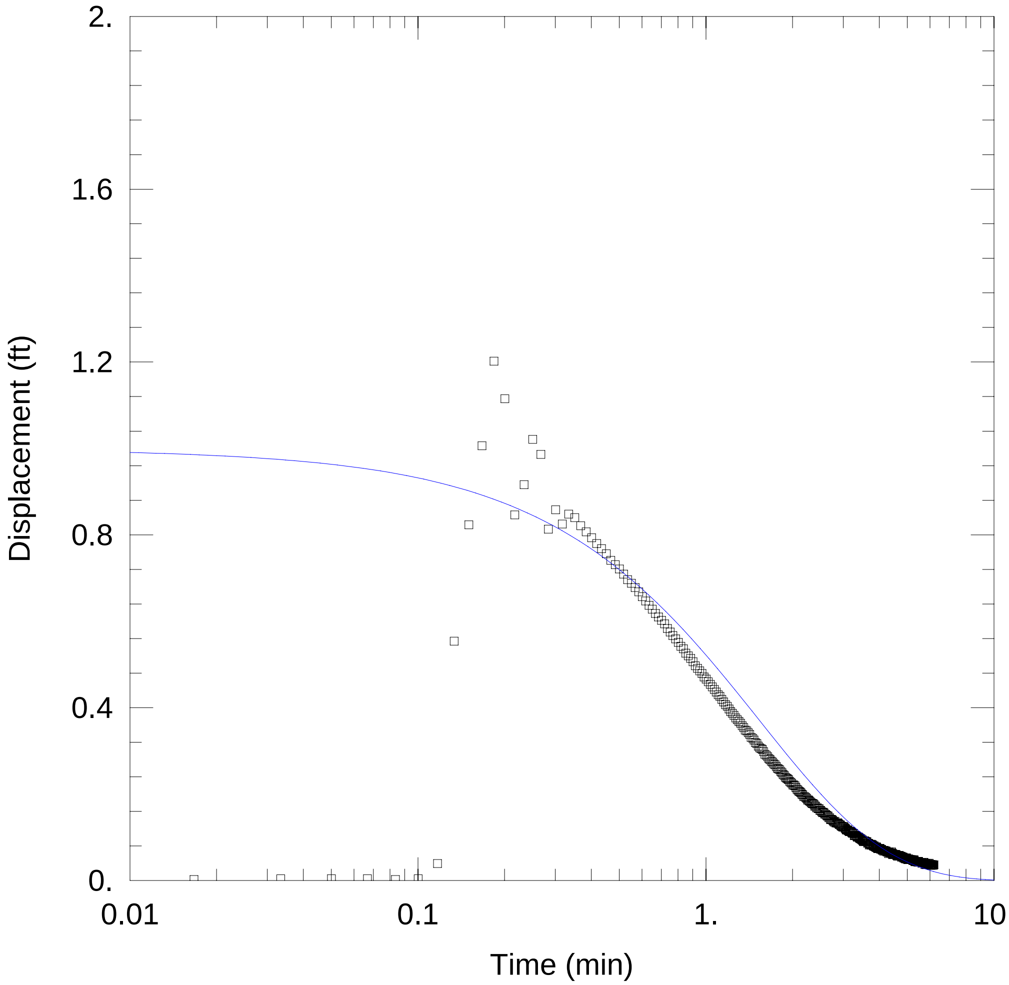
WELL DATA (DMMW0002)

Initial Displacement: 1. ft Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.103 ft/day y0 = 0.9351 ft



DMMW0002 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW2-in1KGS.aqt
Date: 09/15/08 Time: 13:34:35

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMMW0002)

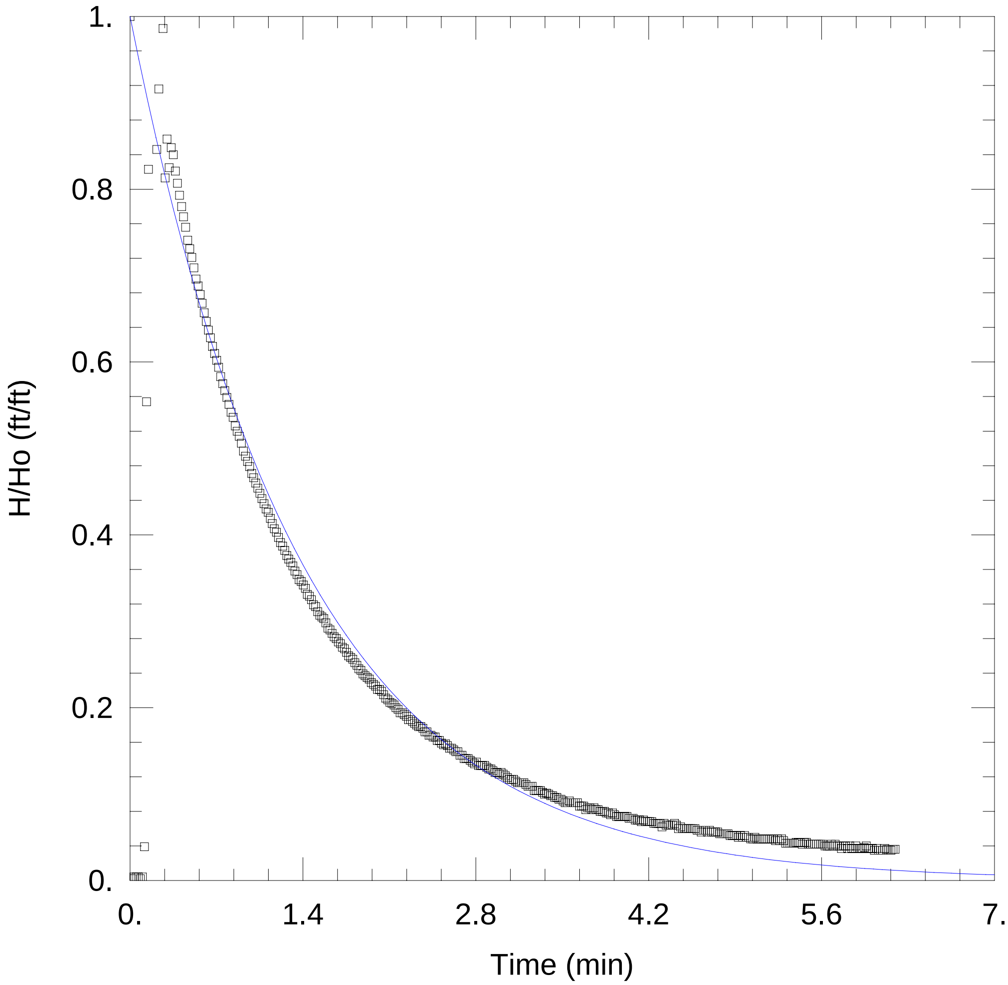
Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft

Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.7692 ft/day
Kz/Kr = 1.
Ss = 1.0E-6 ft^{-1}



DMMW0002 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW2-in1SG.aqt
Date: 09/15/08 Time: 13:34:59

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

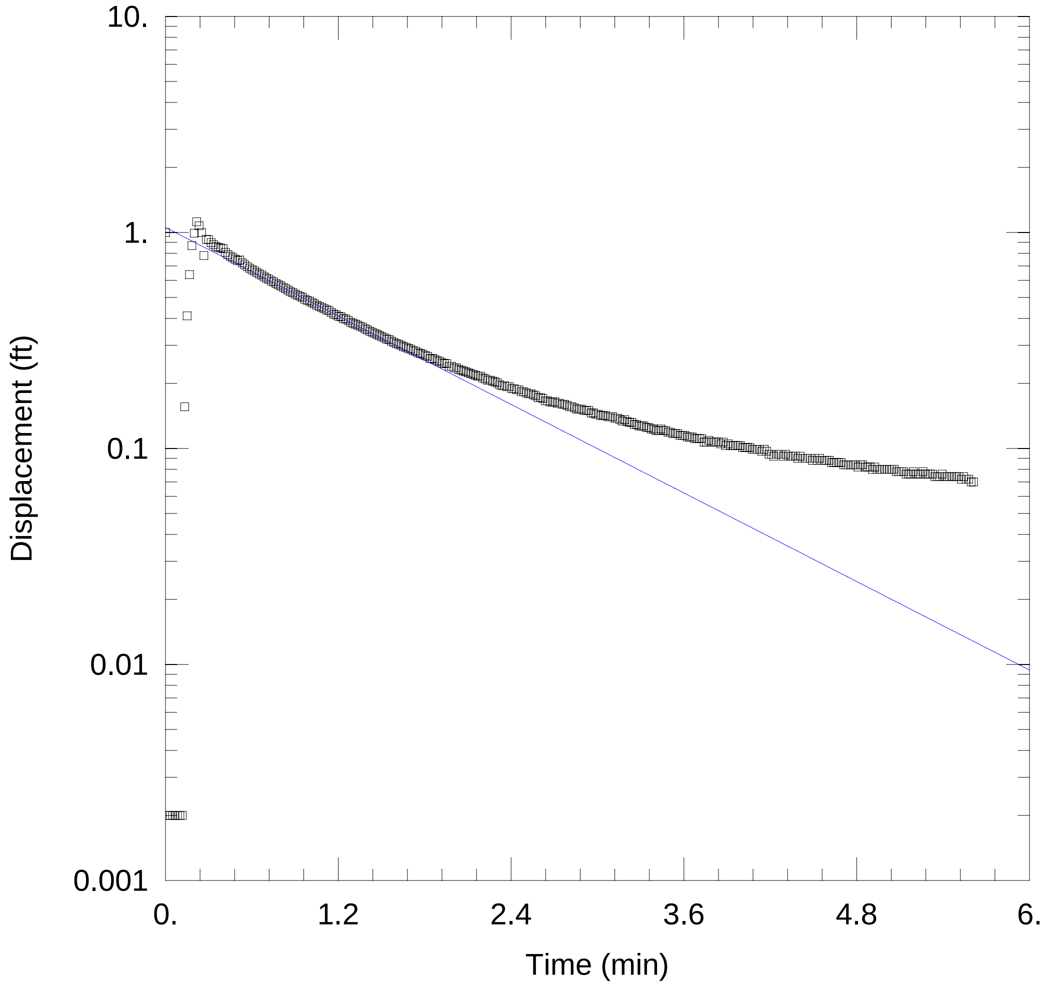
WELL DATA (DMMW0002)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 0.7121 ft/day Le = 0.1 ft



DMMW0002 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW2-in2BR.aqt
Date: 10/28/08 Time: 12:45:57

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

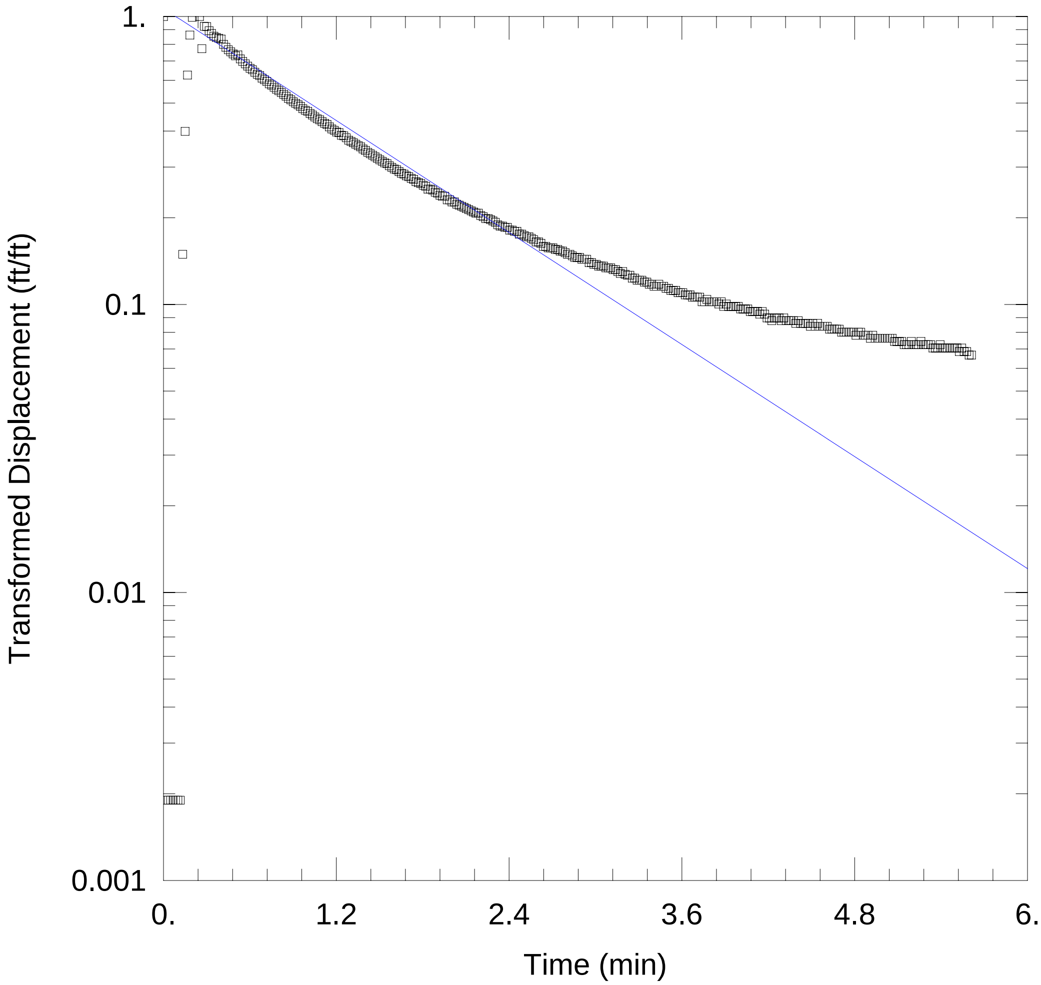
WELL DATA (DMMW2)

Initial Displacement: 1. ft Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.7781 ft/day y0 = 1.054 ft



DMMW0002 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW2-in2DGN.aqt
Date: 09/15/08 Time: 13:35:52

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

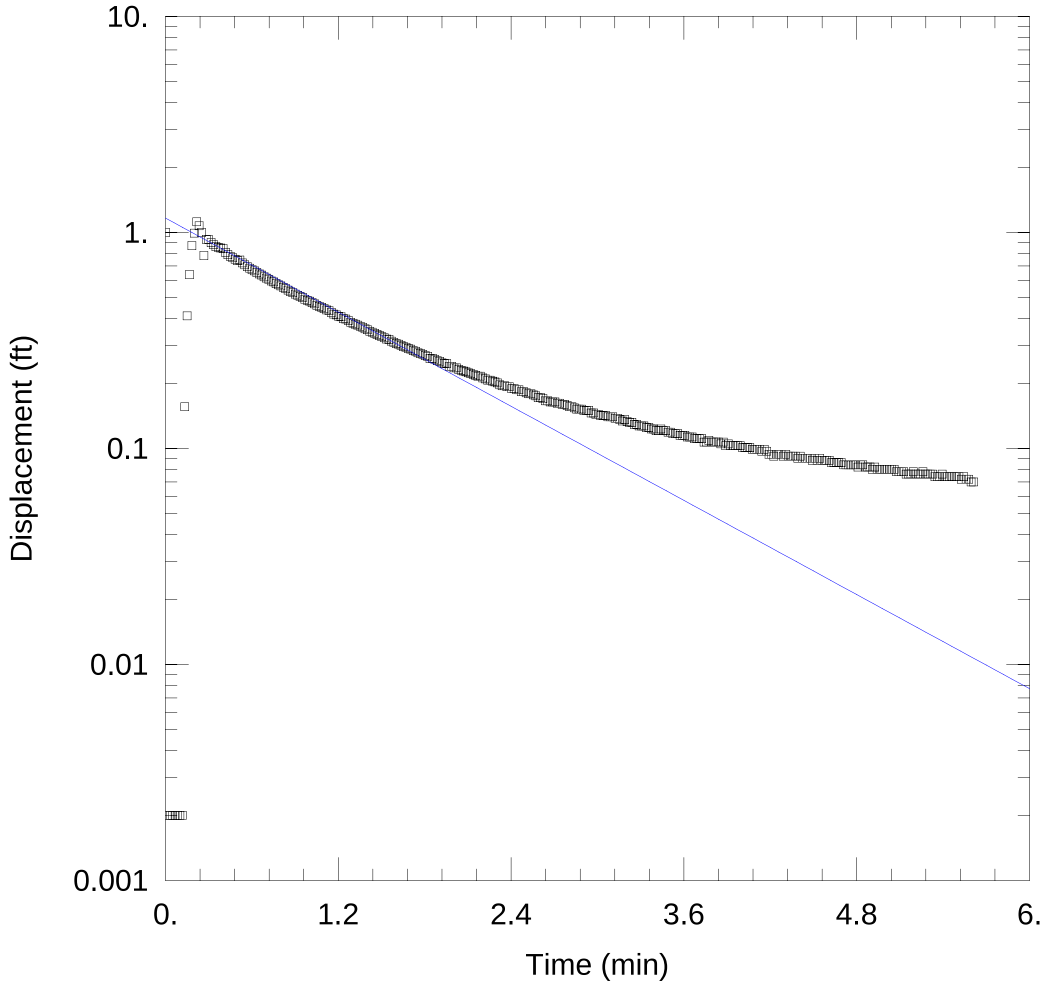
WELL DATA (DMMW2)

Initial Displacement: 1. ft Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 0.8657 ft/day y0 = 1.061 ft



DMMW0002 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW2-in2HV.aqt
Date: 09/15/08 Time: 13:36:11

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

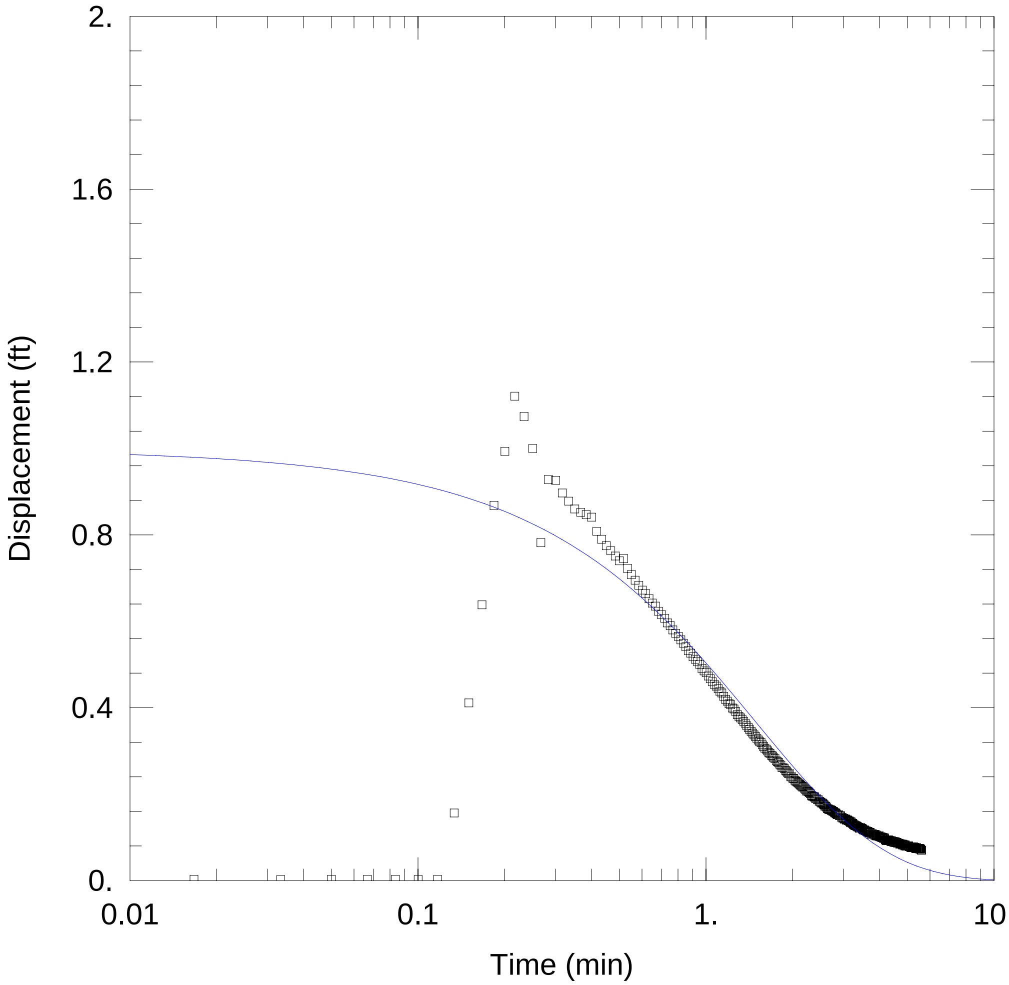
WELL DATA (DMMW2)

Initial Displacement: 1. ft Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.276 ft/day y0 = 1.165 ft



DMMW0002 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW2-in2KGS.aqt
Date: 09/15/08 Time: 13:36:30

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMMW2)

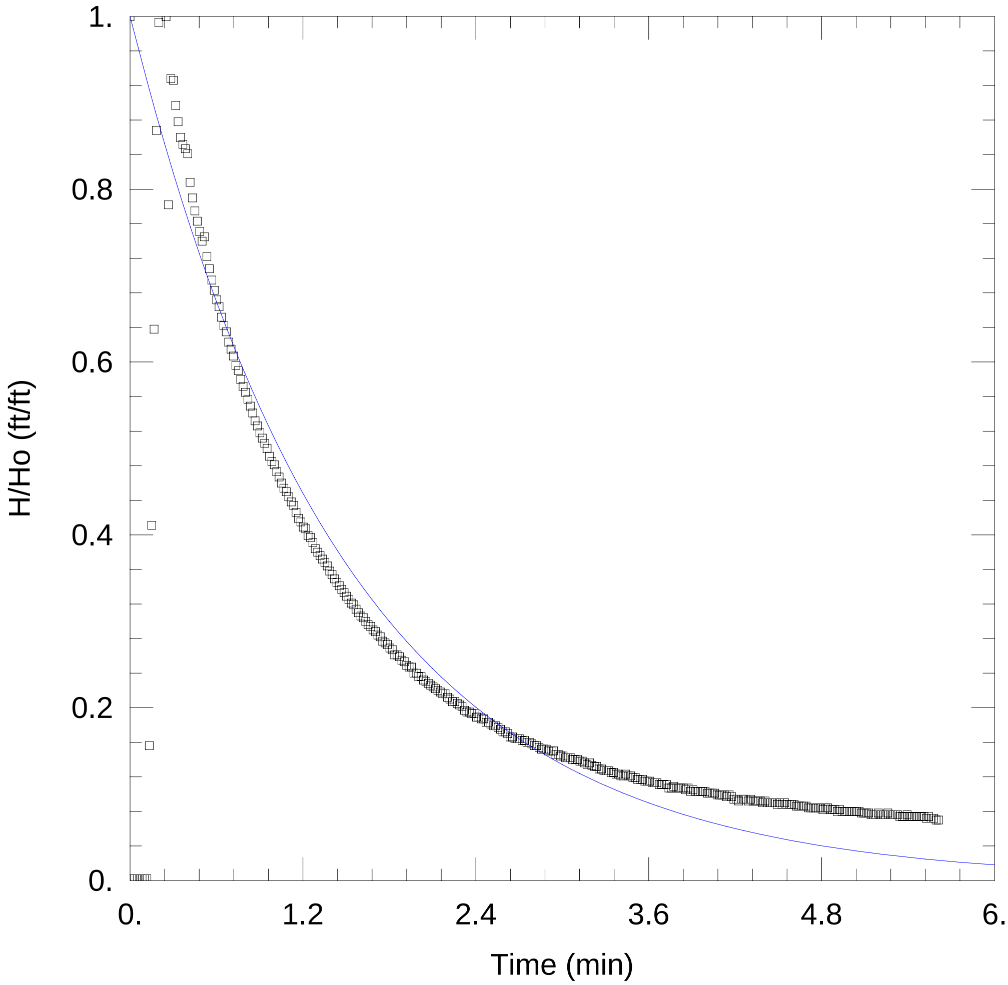
Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft

Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.7906 ft/day
Kz/Kr = 1.
Ss = 5.518E-6 ft^{-1}



DMMW0002 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW2-in2SG.aqt
Date: 09/15/08 Time: 13:37:42

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

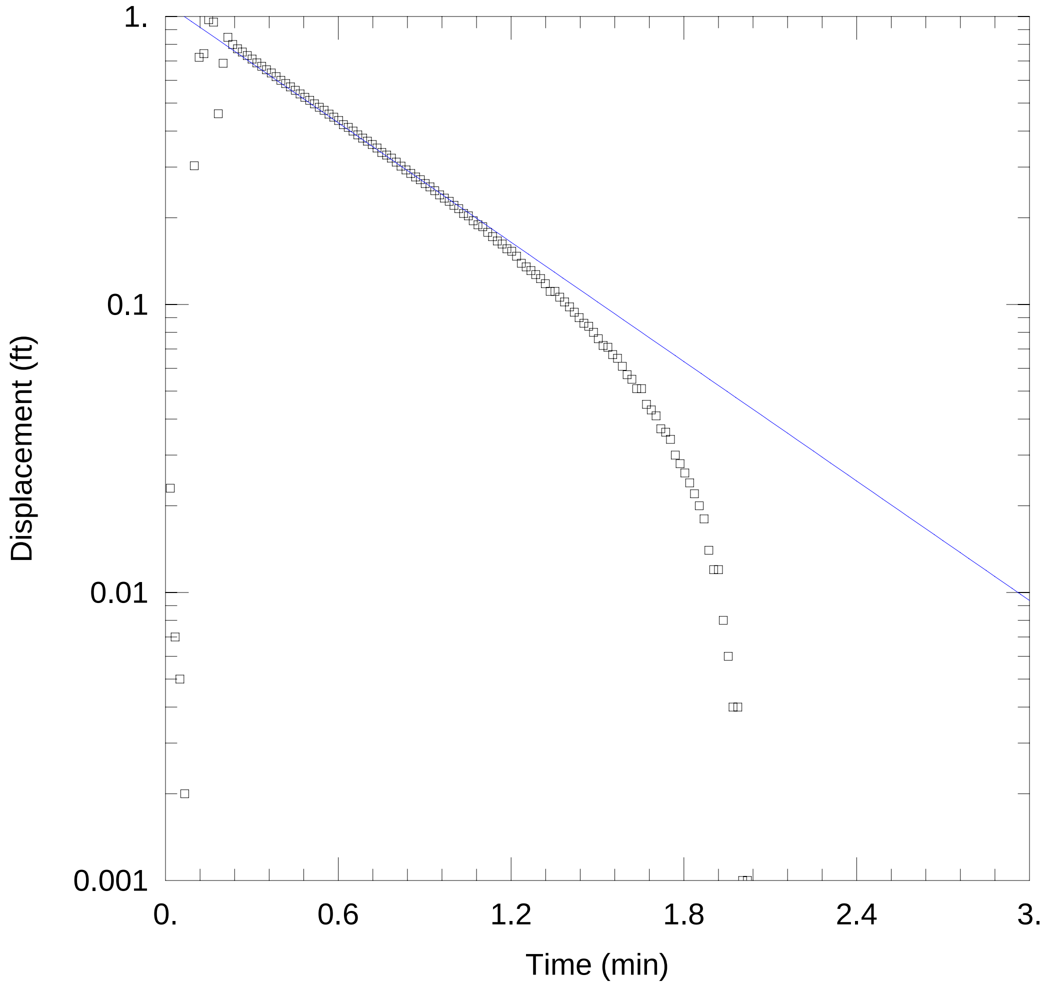
WELL DATA (DMMW2)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 0.6624 ft/day Le = 292.4 ft



DMMW0003 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW3-in1BR.aqt
Date: 10/28/08
Time: 12:49:01

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

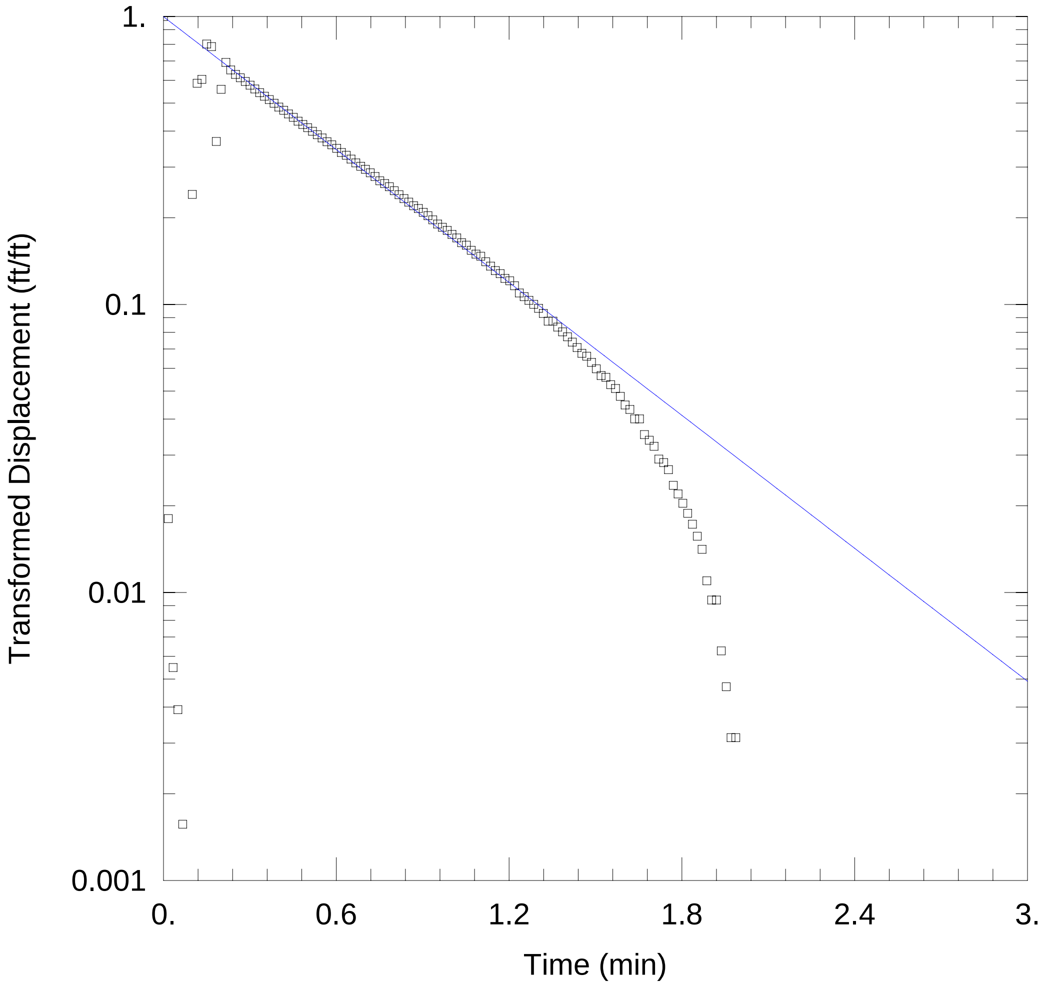
WELL DATA (DMMW0003)

Initial Displacement: 1.2 ft
Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft
Screen Length: 10. ft
Casing Radius: 0.08 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.62 ft/day
y0 = 1.109 ft



DMMW0003 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW3-in1DGN.aqt
Date: 09/15/08 Time: 13:38:21

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

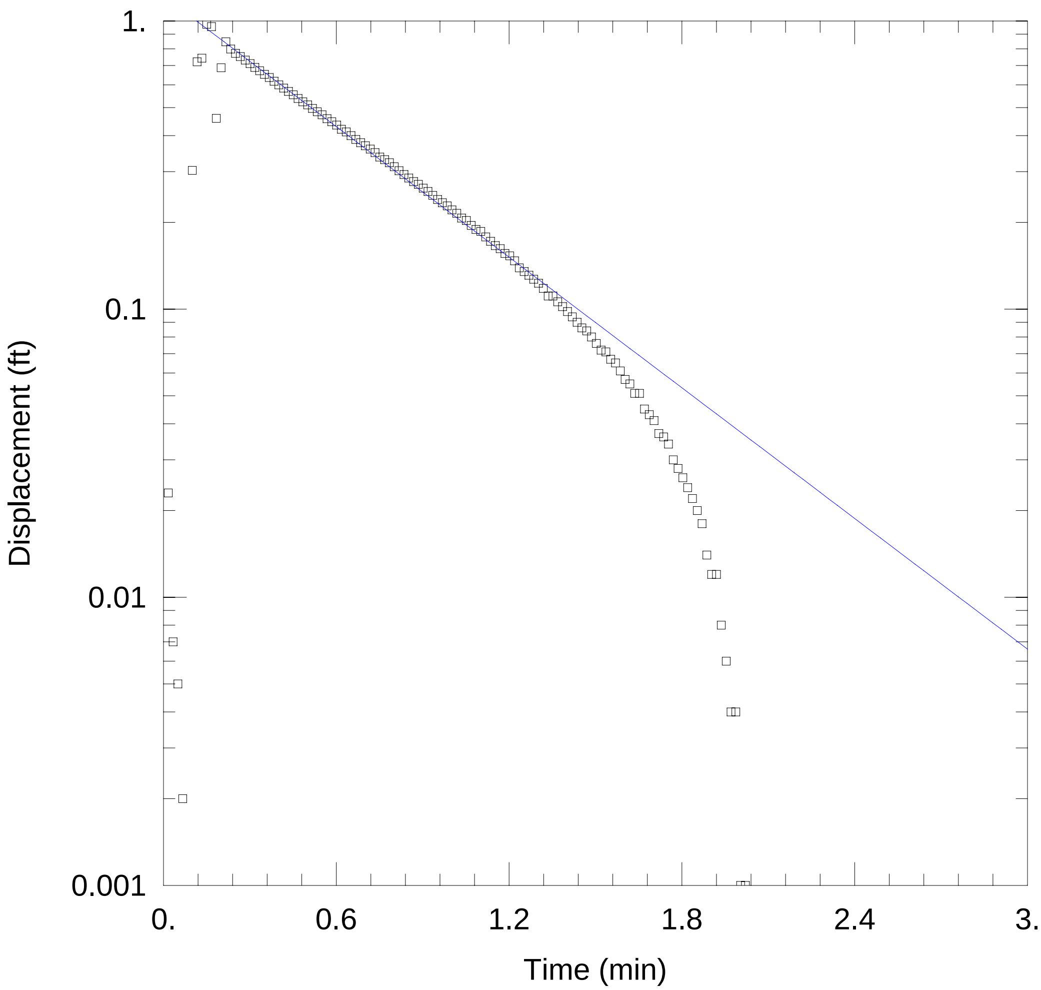
WELL DATA (DMMW0003)

Initial Displacement: 1.2 ft Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 2.054 ft/day y0 = 1.197 ft



DMMW0003 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW3-in1HV.aqt
Date: 09/15/08 Time: 13:38:42

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

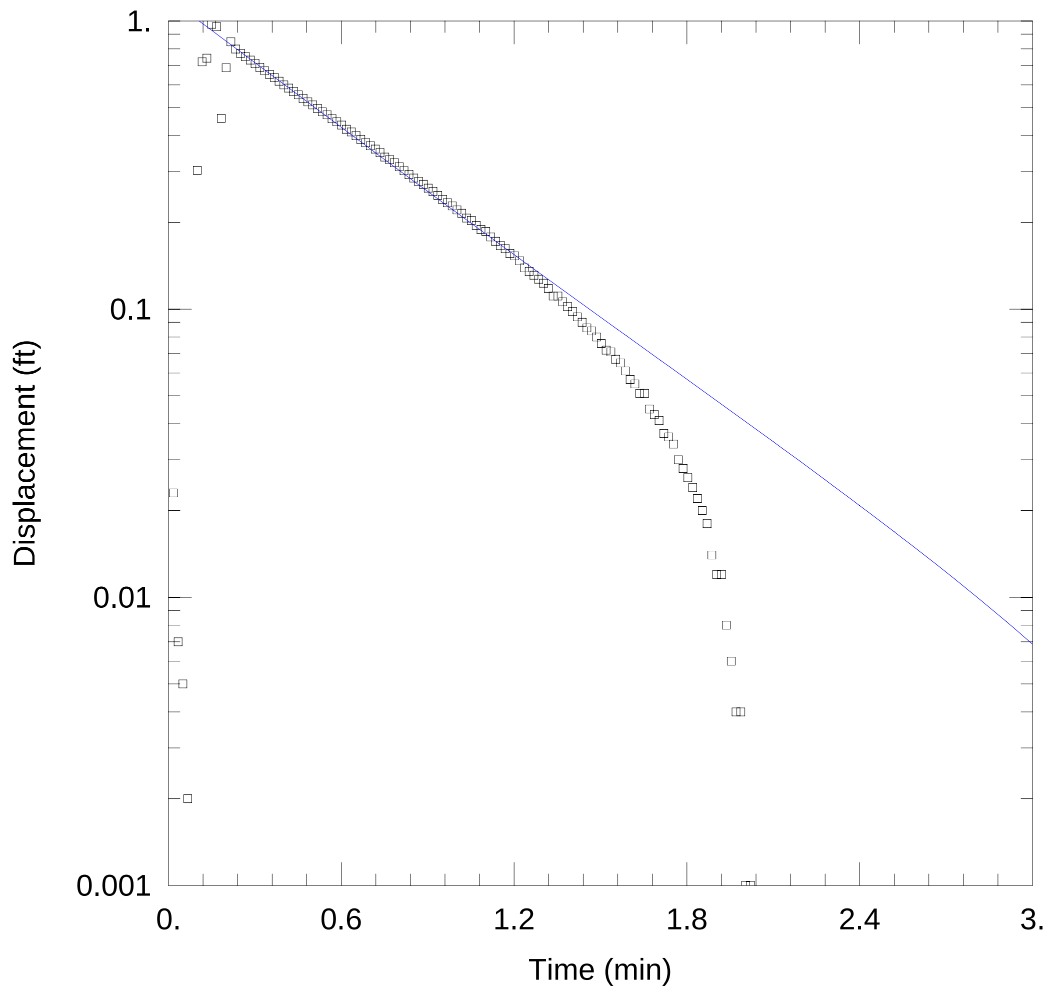
WELL DATA (DMMW0003)

Initial Displacement: 1.2 ft Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 2.654 ft/day y0 = 1.22 ft



DMMW0003 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW3-in1KGS.aqt
Date: 09/15/08
Time: 13:39:03

AQUIFER DATA

Saturated Thickness: 30. ft

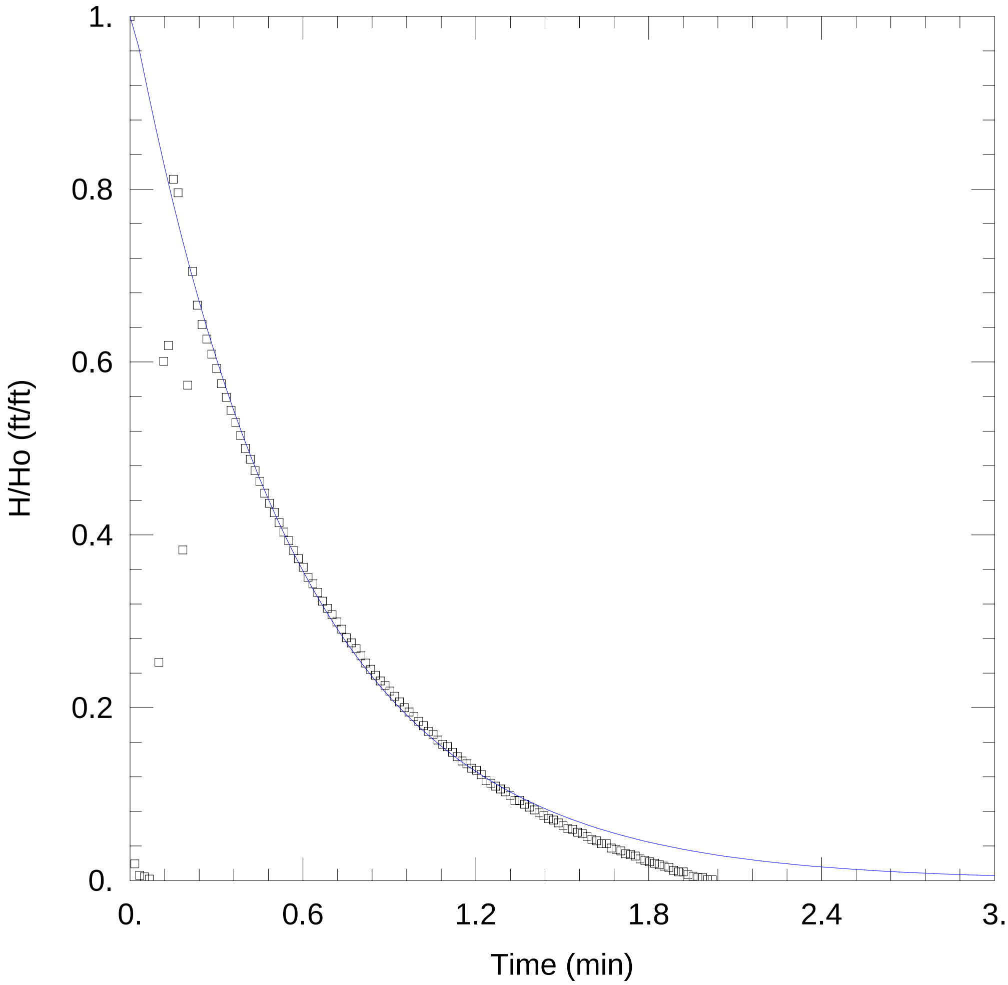
WELL DATA (DMMW0003)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 12.39 ft
Casing Radius: 0.08 ft
Static Water Column Height: 12.39 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 2.149 ft/day
Kz/Kr = 1.
Ss = 3.333E-12 ft^{-1}



DMMW0003 - FALLING HEAD TRIAL 1

Data Set: L:\...\DMMW3-in1SG.aqt
Date: 09/15/08 | Time: 13:39:21

AQUIFER DATA

Saturated Thickness: 30. ft | Anisotropy Ratio (Kz/Kr): 1.

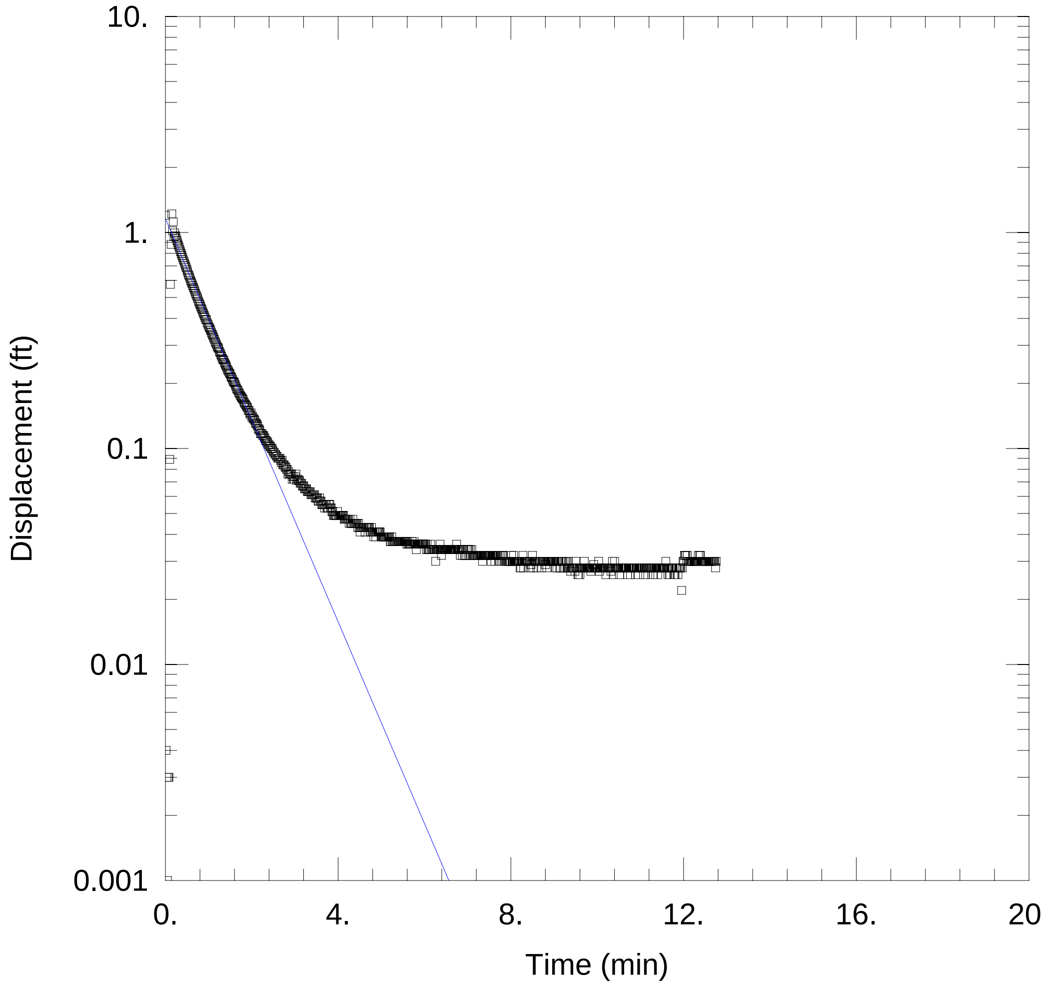
WELL DATA (DMMW0003)

Initial Displacement: 1.2 ft | Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft | Screen Length: 10. ft
Casing Radius: 0.08 ft | Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined | Solution Method: Springer-Gelhar

K = 1.742 ft/day | Le = 644. ft



DMMW0003 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW3-in2BR.aqt
Date: 10/28/08 Time: 12:51:02

AQUIFER DATA

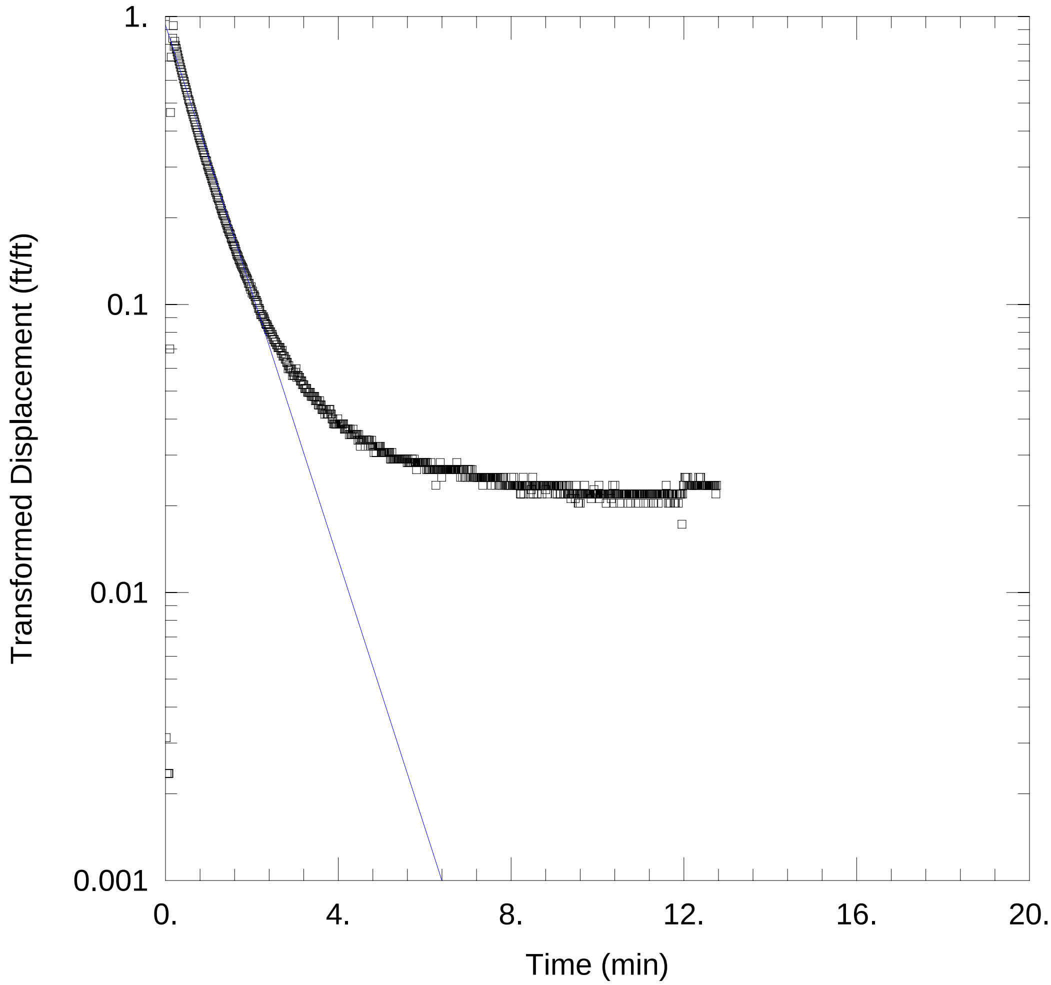
Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (DMM0003)

Initial Displacement: 1.2 ft
Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft
Screen Length: 10. ft
Casing Radius: 0.08 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.094 ft/day
y0 = 1.159 ft



DMMW0003 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW3-in2DGN.aqt
Date: 09/15/08 Time: 13:40:01

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

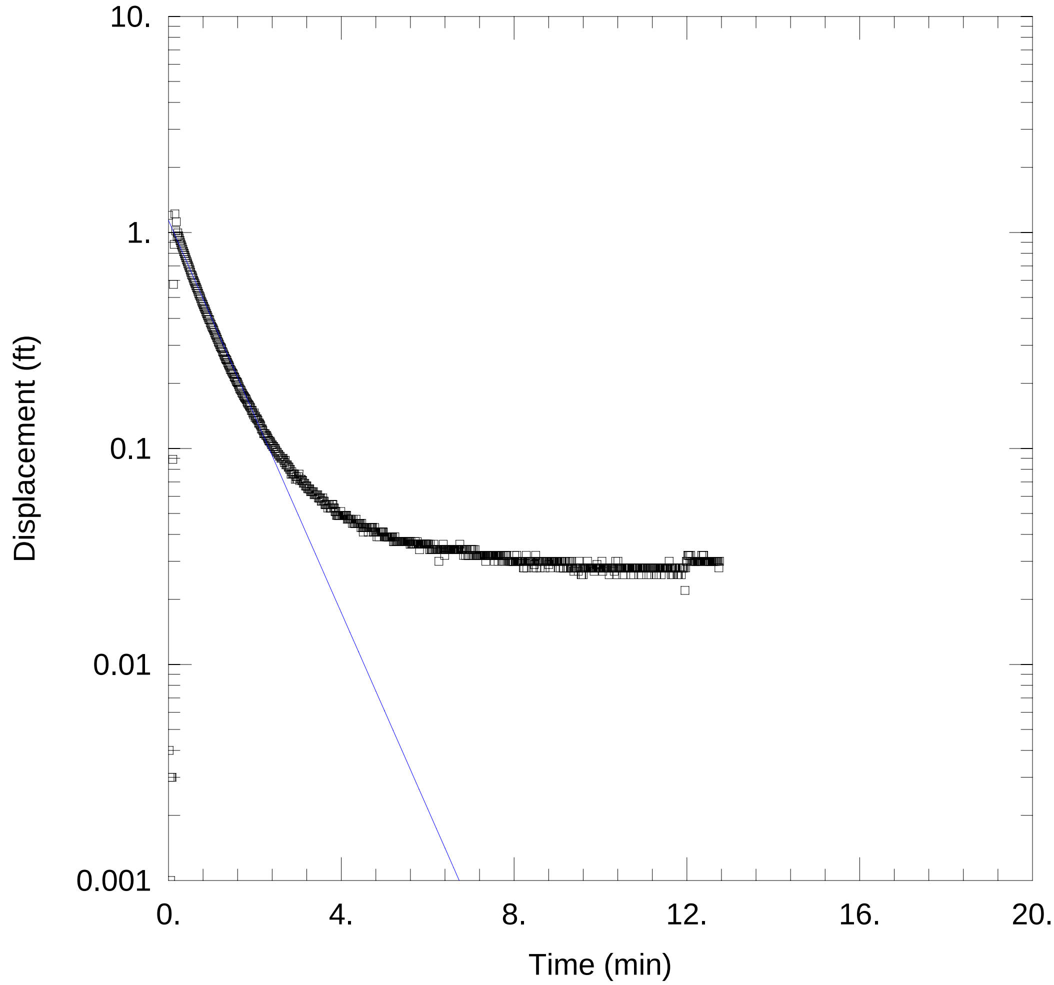
WELL DATA (DMM0003)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 12.39 ft
Casing Radius: 0.08 ft
Static Water Column Height: 12.39 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 1.24 ft/day y0 = 1.124 ft



DMMW0003 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW3-in2HV.aqt
Date: 09/15/08 Time: 13:40:23

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

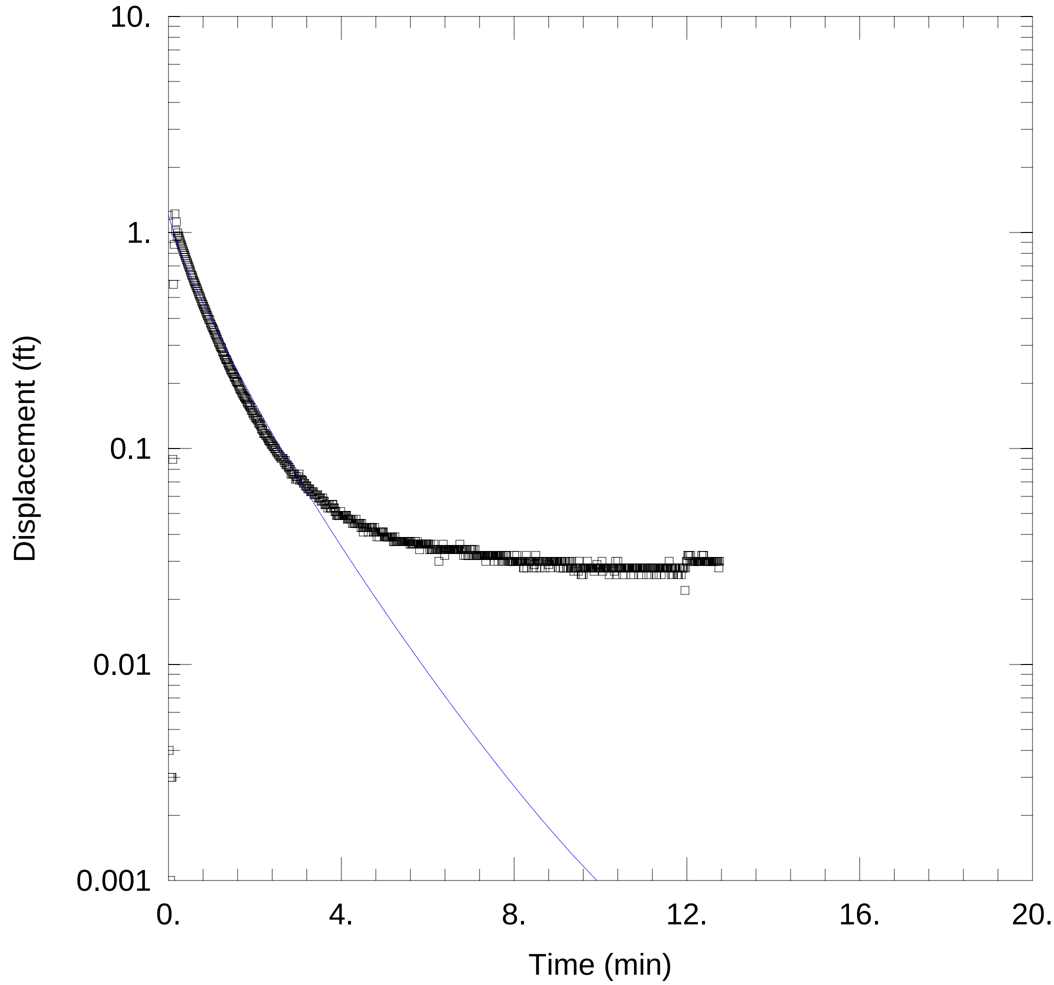
WELL DATA (DMM0003)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 12.39 ft
Casing Radius: 0.08 ft
Static Water Column Height: 12.39 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 1.595 ft/day
y0 = 1.137 ft



DMMW0003 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW3-in2KGS.aqt
Date: 09/15/08 Time: 13:40:40

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMM0003)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 12.39 ft
Casing Radius: 0.08 ft

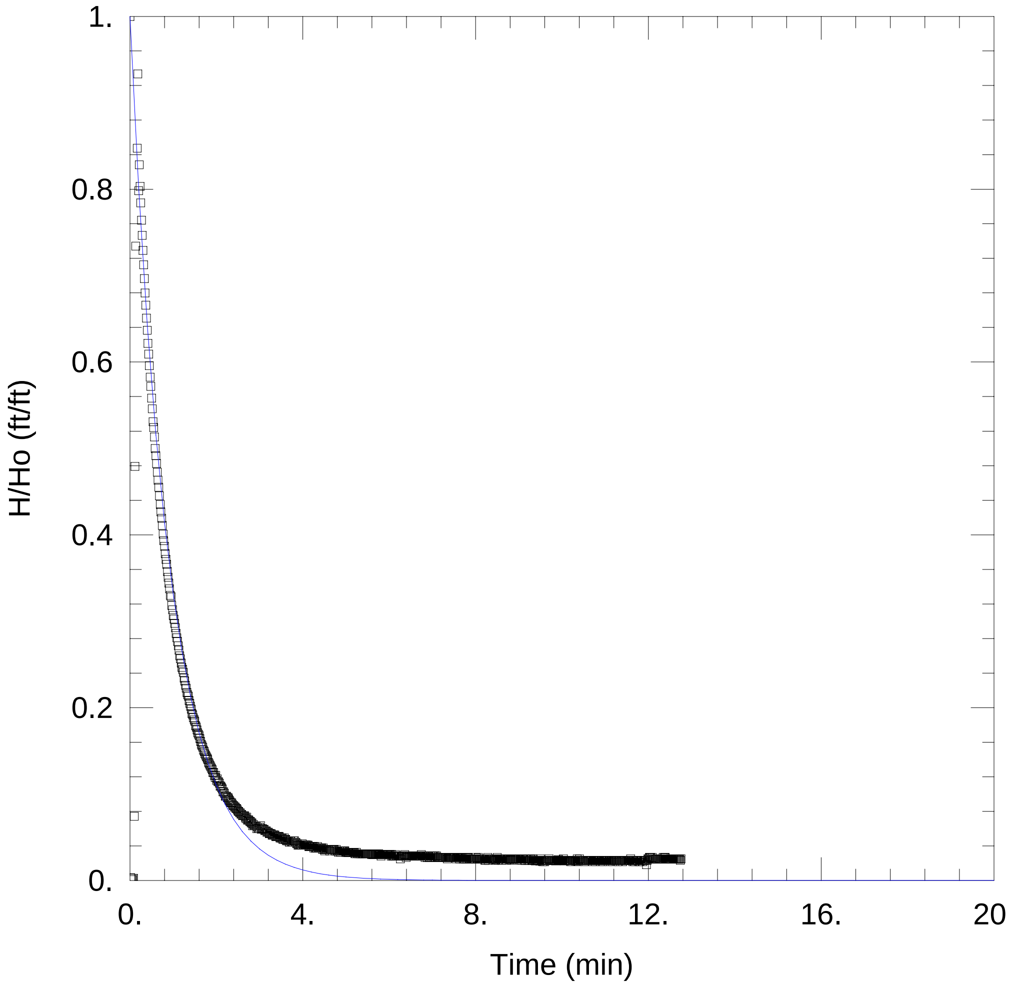
Static Water Column Height: 12.39 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 1.294 ft/day
Kz/Kr = 1.

Ss = 3.315E-5 ft^{-1}



DMMW0003 - FALLING HEAD TRIAL 2

Data Set: L:\...\DMMW3-in2SG.aqt
Date: 09/15/08 Time: 13:40:55

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

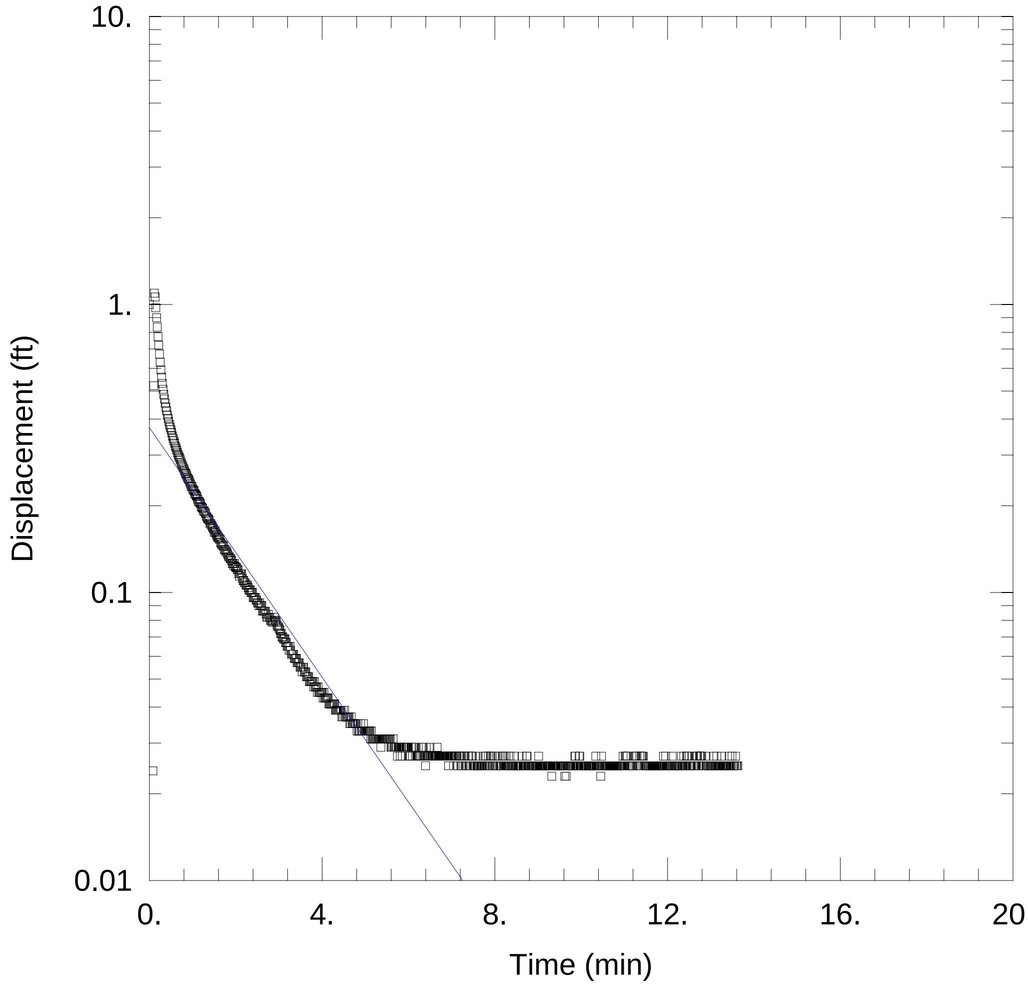
WELL DATA (DMM0003)

Initial Displacement: 1.2 ft Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 1.124 ft/day Le = 0.1 ft



DMMW0001- RISING HEAD 1

Data Set: L:\...\DMMW1-out1BR.aqt
Date: 09/15/08 Time: 13:44:37

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

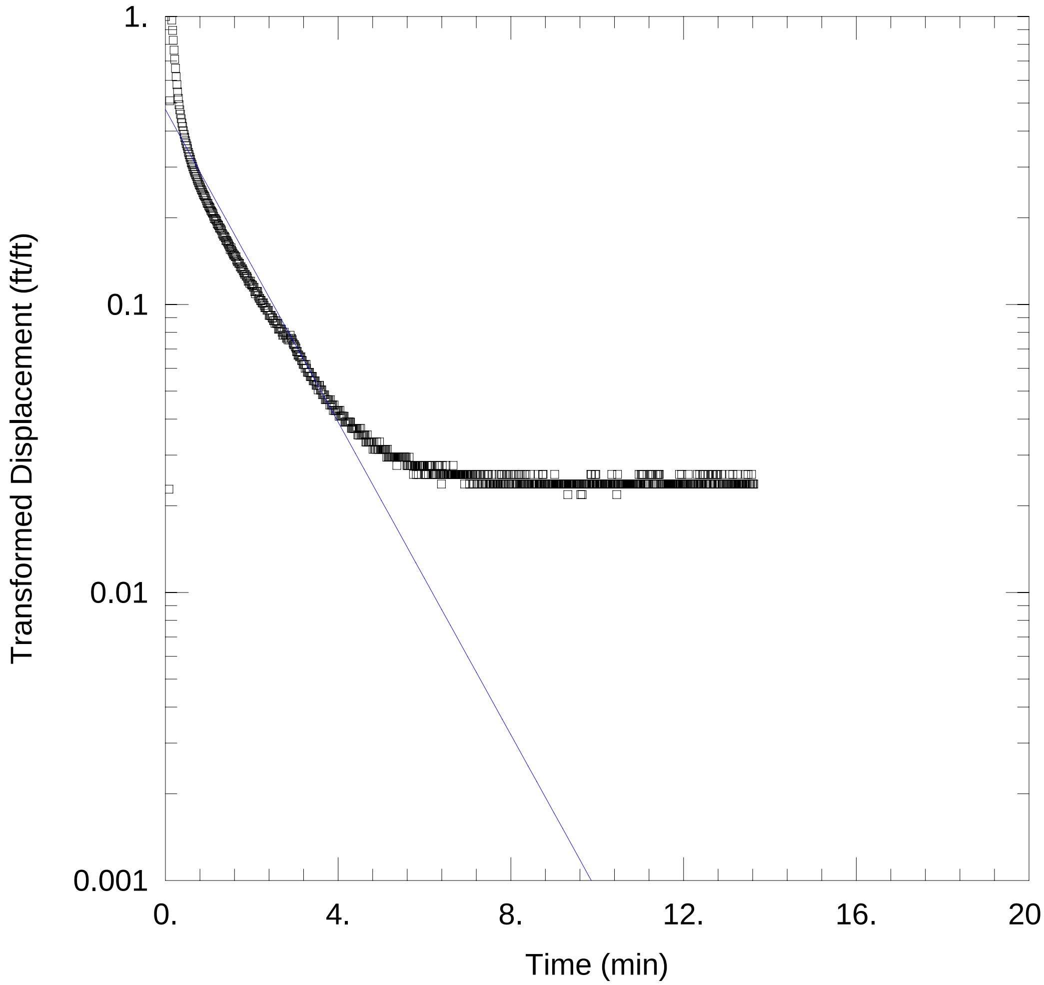
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.364 ft/day
y0 = 0.373 ft



DMMW0001- RISING HEAD 1

Data Set: L:\...\DMMW1-out1DGN.aqt
Date: 09/15/08 Time: 13:44:54

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 0.001

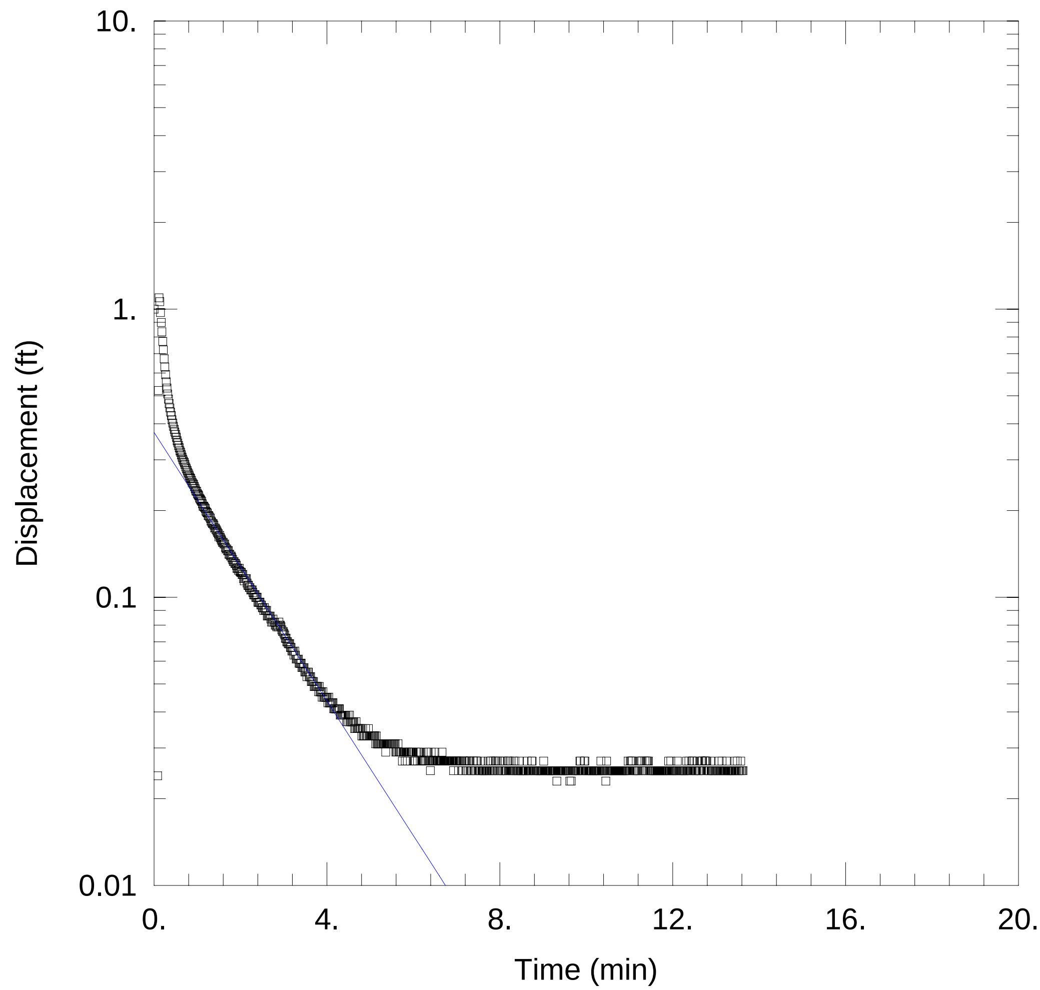
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 5.035 ft/day y0 = 0.4878 ft



DMMW0001- RISING HEAD 1

Data Set: L:\...\DMMW1-out1HV.aqt
Date: 09/15/08 Time: 13:45:15

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

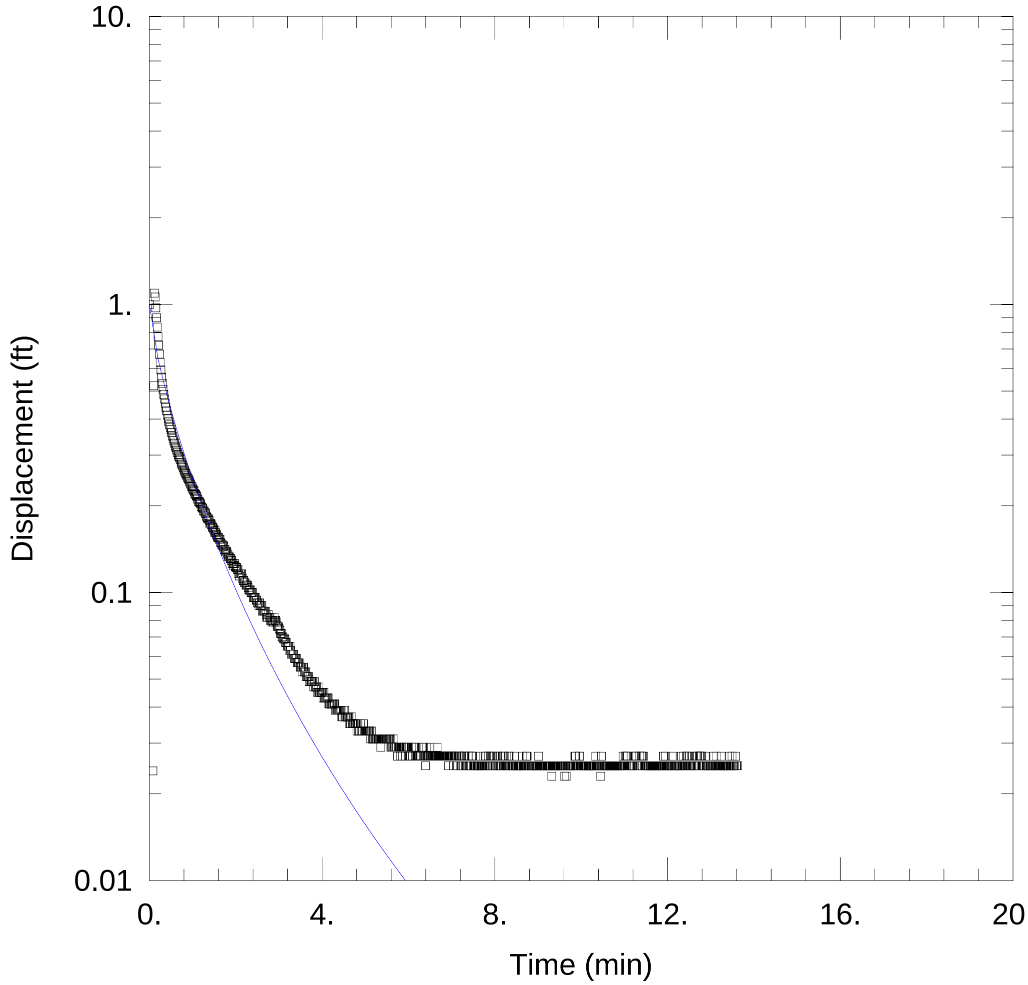
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 5.69 ft/day
y0 = 0.373 ft



DMMW0001- RISING HEAD 1

Data Set: L:\...\DMMW1-out1KGS.aqt
Date: 09/15/08 Time: 13:45:39

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft

Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

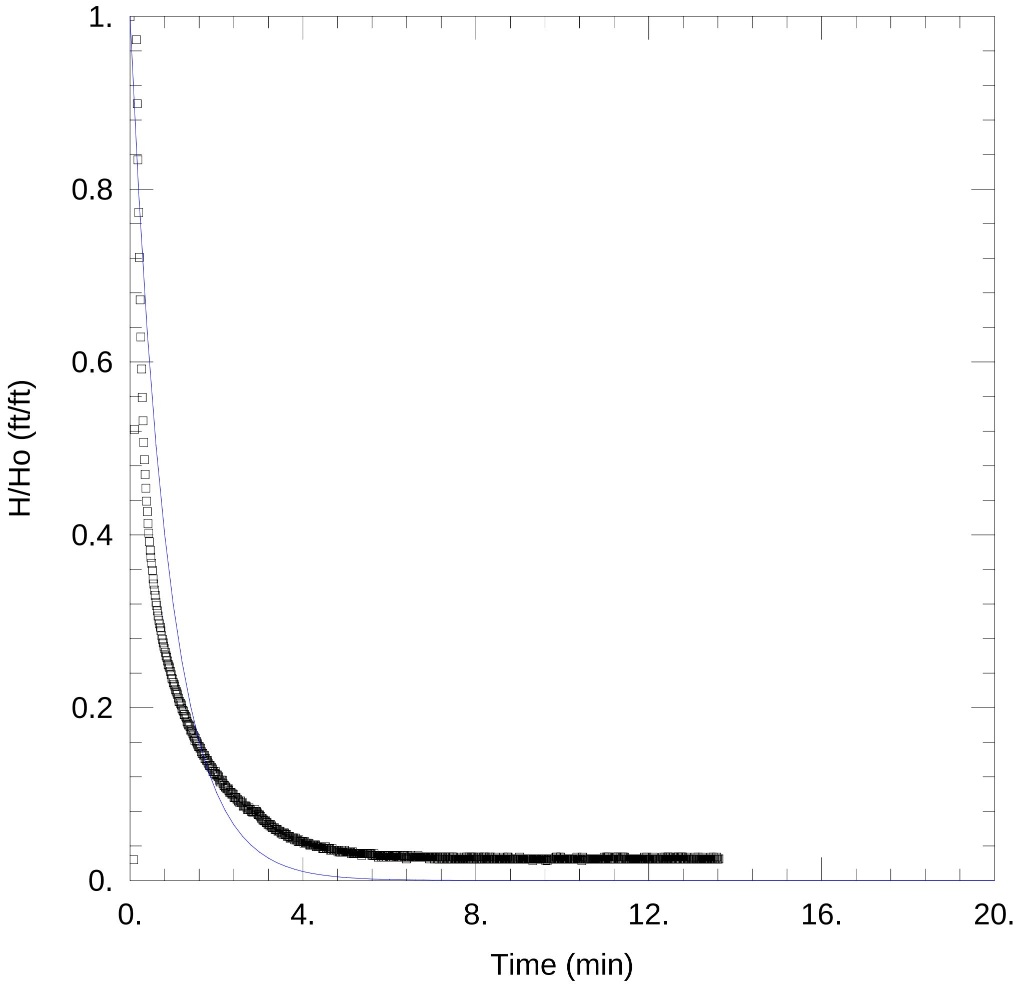
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 1.366 ft/day
Kz/Kr = 1.

Ss = 0.0001421 ft^{-1}



DMMW0001- RISING HEAD 1

Data Set: L:\...\DMMW1-out1SG.aqt
Date: 09/15/08 Time: 13:46:04

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 0.001

WELL DATA (DMMW0001)

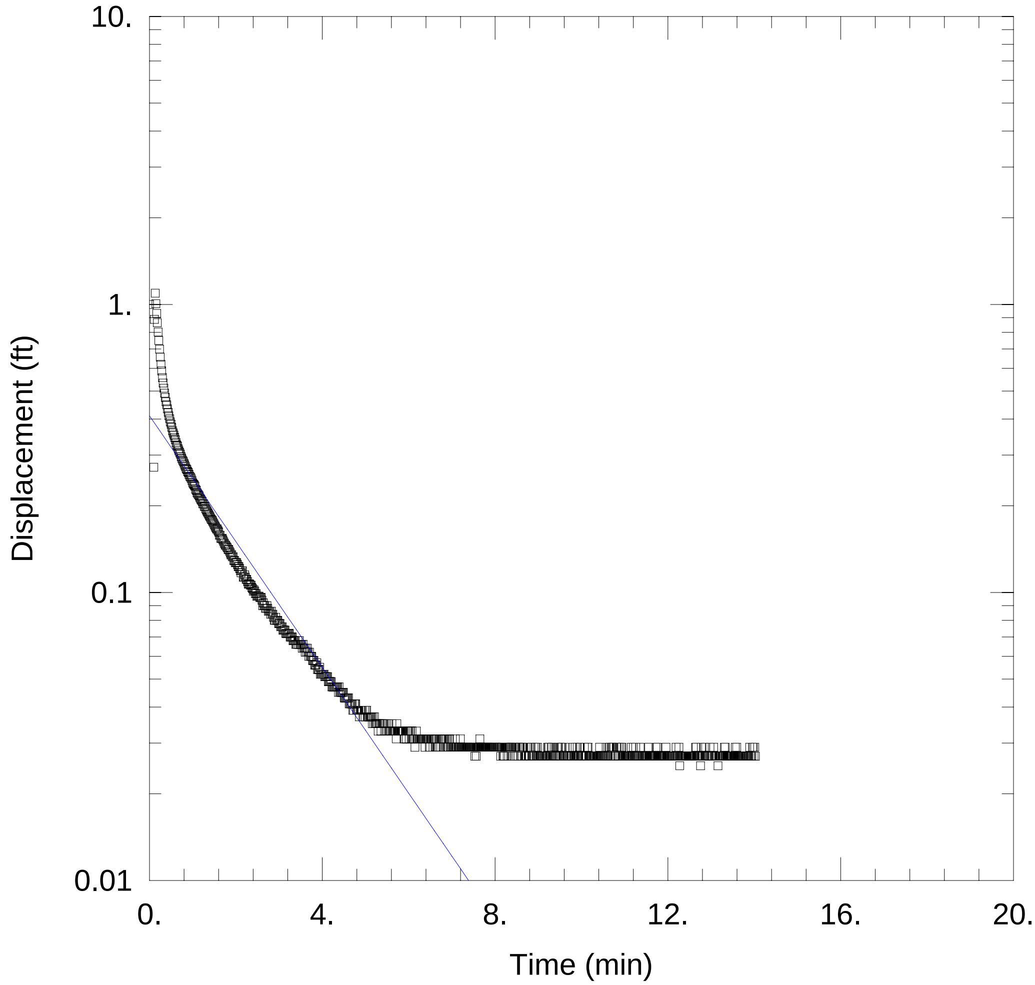
Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft

Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 2.746 ft/day Le = 1.5 ft



DMMW0001 - RISING HEAD 2

Data Set: L:\...\DMMW1-out2BR.aqt
Date: 09/15/08 Time: 14:00:08

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

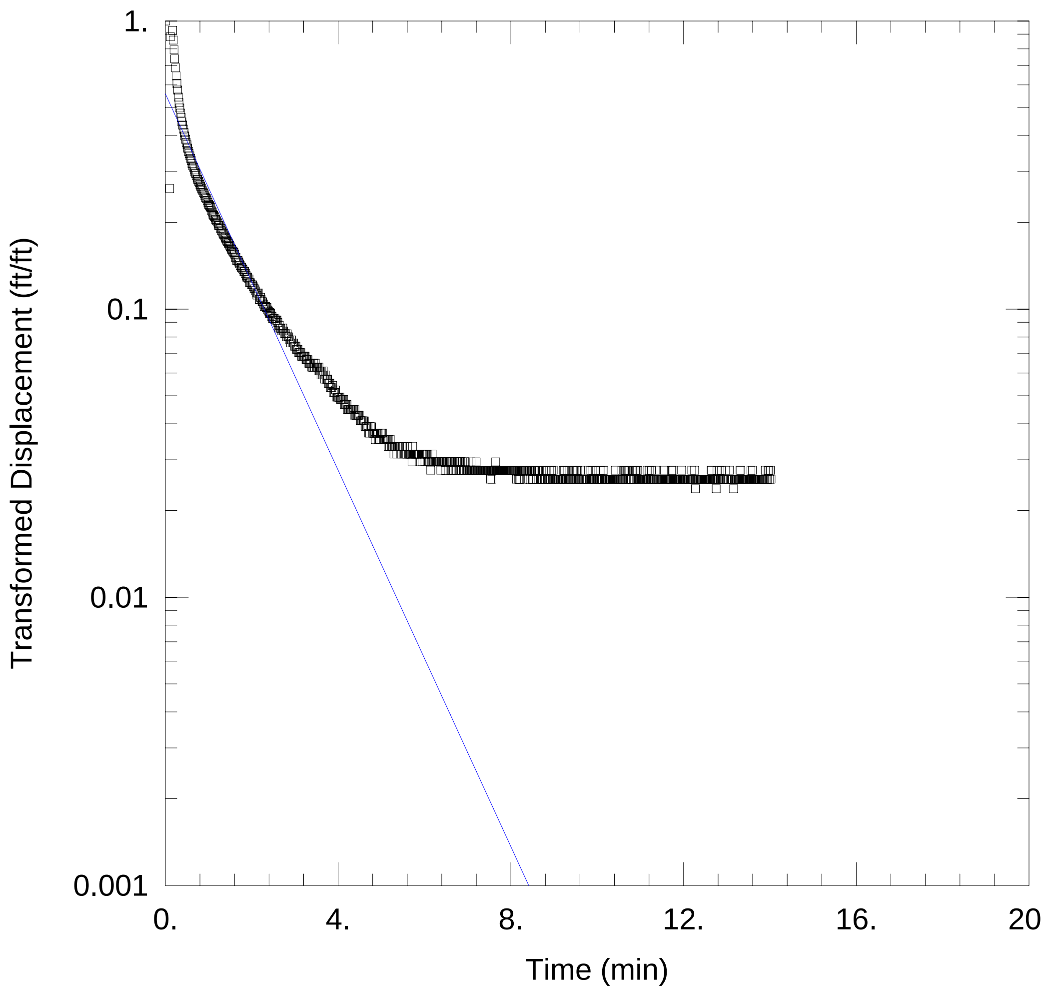
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 12.63 ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.571 ft/day
y0 = 0.4104 ft



DMMW0001 - RISING HEAD 2

Data Set: L:\...\DMMW1-out2DGN.aqt
Date: 09/15/08 Time: 14:00:31

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

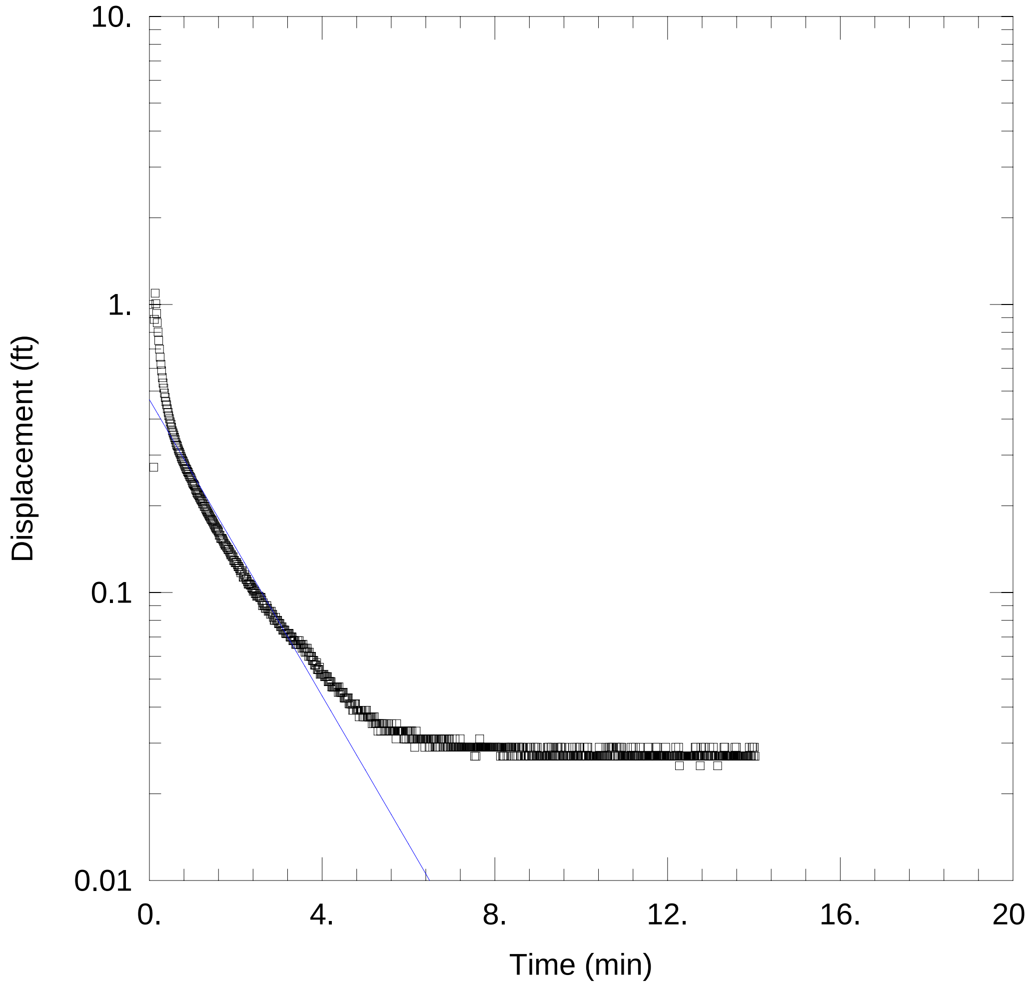
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 6.058 ft/day y0 = 0.5708 ft



DMMW0001 - RISING HEAD 2

Data Set: L:\...\DMMW1-out2HV.aqt
Date: 09/15/08 Time: 14:00:51

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

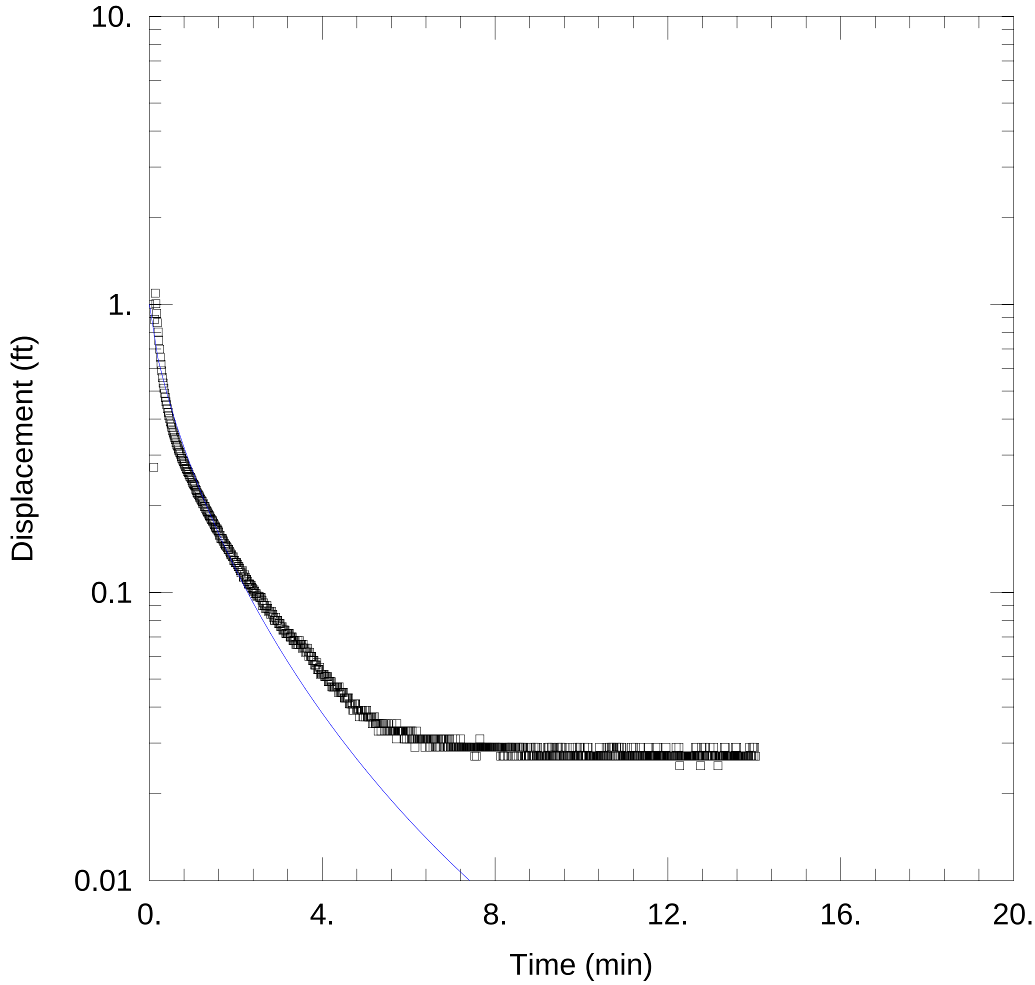
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 6.276 ft/day y0 = 0.4669 ft



DMMW0001 - RISING HEAD 2

Data Set: L:\...\DMMW1-out2KGS.aqt
Date: 09/15/08
Time: 14:01:07

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

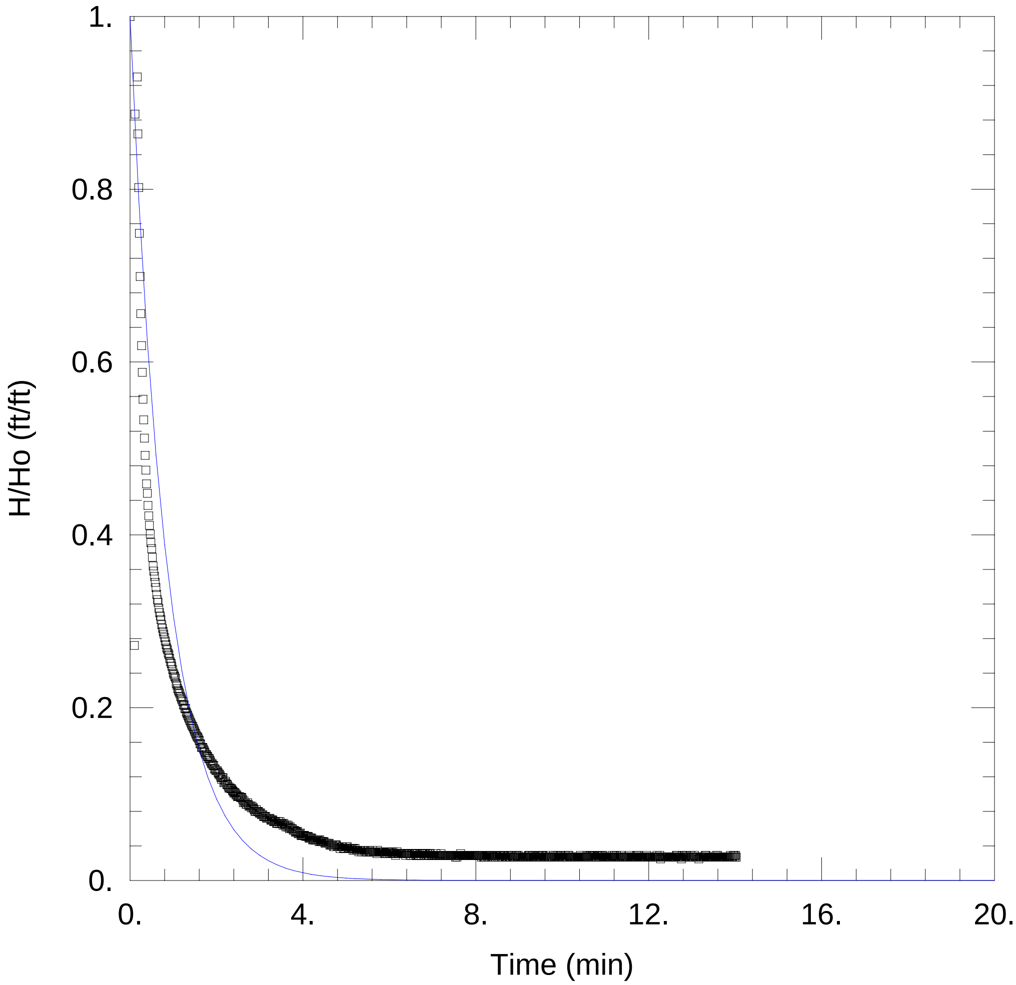
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 1.211 ft/day
Ss = 0.000211 ft^{-1}
Kz/Kr = 1.



DMMW0001 - RISING HEAD 2

Data Set: L:\...\DMMW1-out2SG.aqt
Date: 09/15/08 Time: 14:01:45

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0001
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

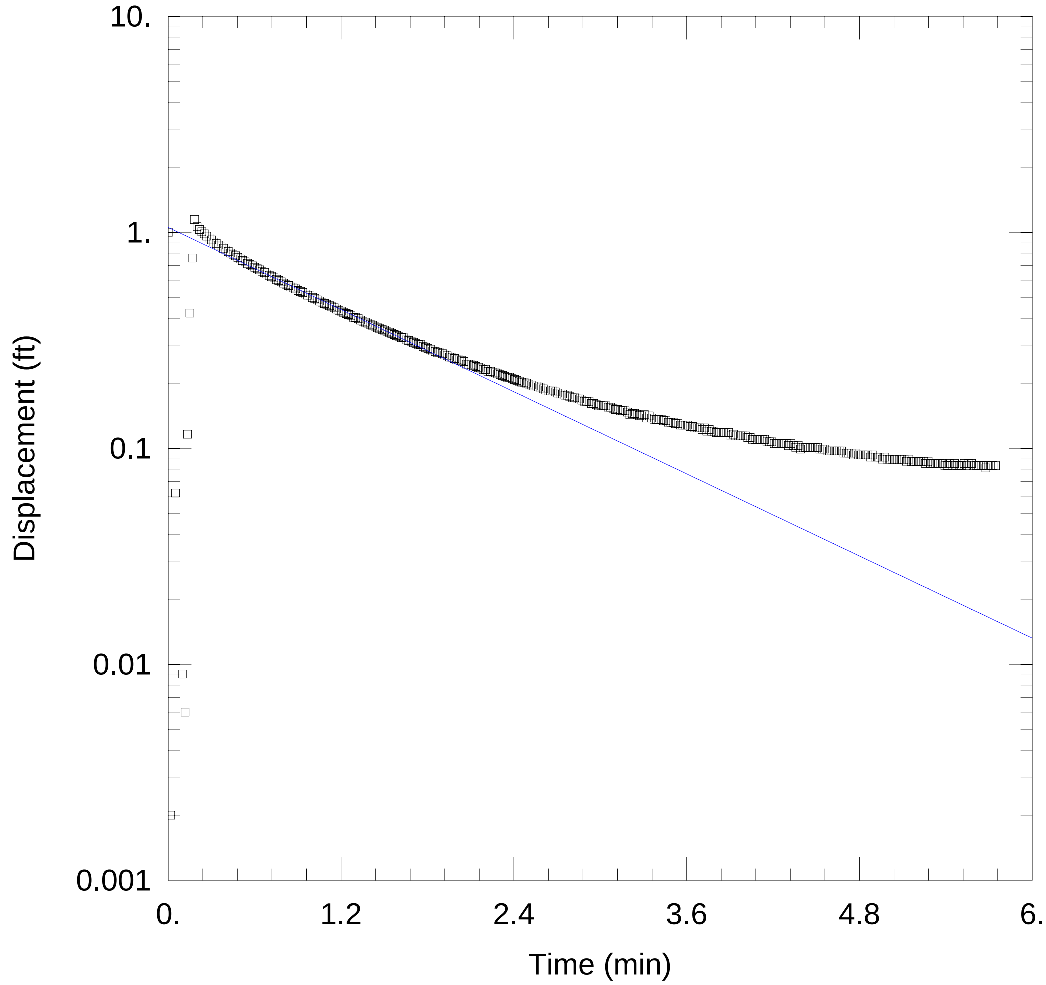
WELL DATA (DMMW0001)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08 ft
Static Water Column Height: 7.37 ft
Screen Length: 10. ft
Well Radius: 0.365 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 1.147 ft/day Le = 0.75 ft



DMMW0002-RISING HEAD TRIAL 1

Data Set: L:\...\DMMW2-out1BR.aqt
Date: 10/28/08 Time: 12:58:05

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin Williams
Location: Gibbsboro
Test Well: DMMW002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

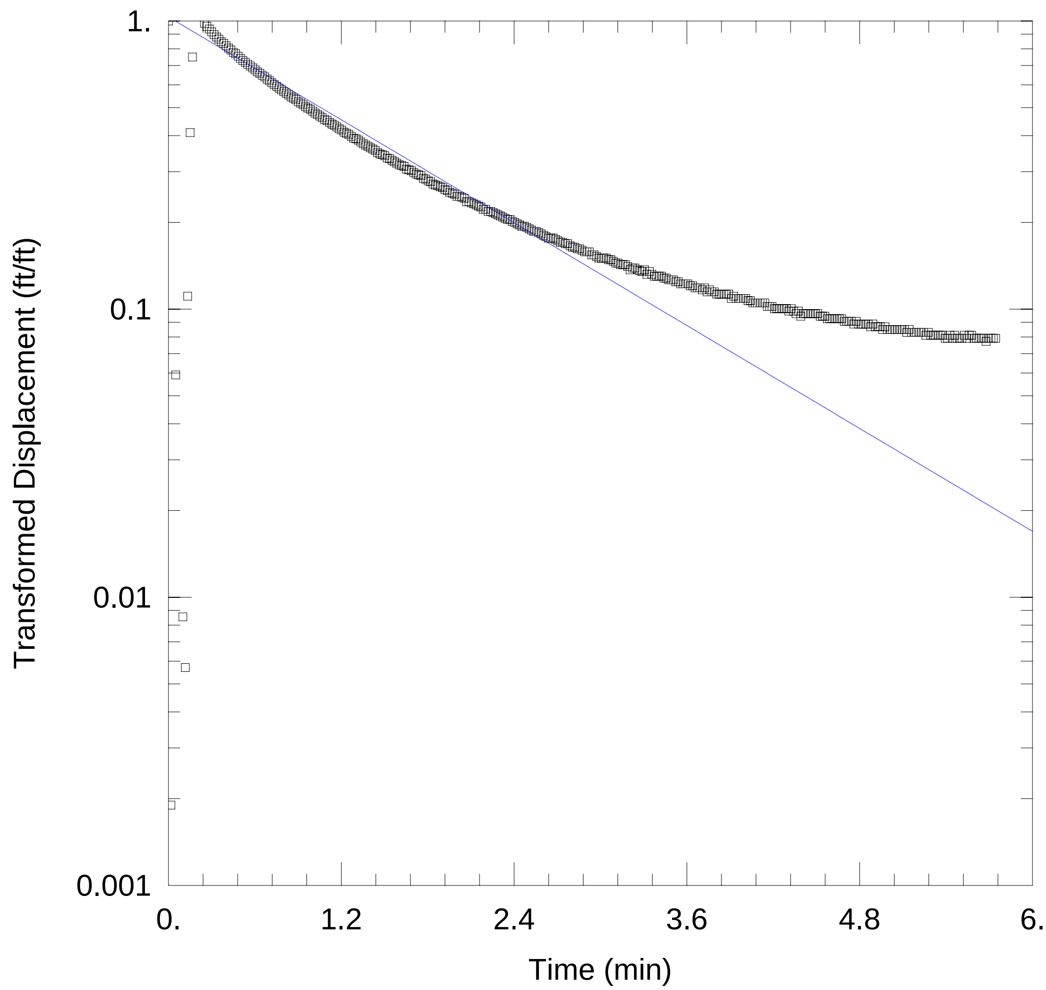
WELL DATA (DMMW0002)

Initial Displacement: 1. ft Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.7221 ft/day y0 = 1.052 ft



DMMW0002-RISING HEAD TRIAL 1

Data Set: L:\...\DMMW2-out1DGN.aqt
Date: 09/15/08 Time: 14:02:52

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin Williams
Location: Gibbsboro
Test Well: DMMW002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

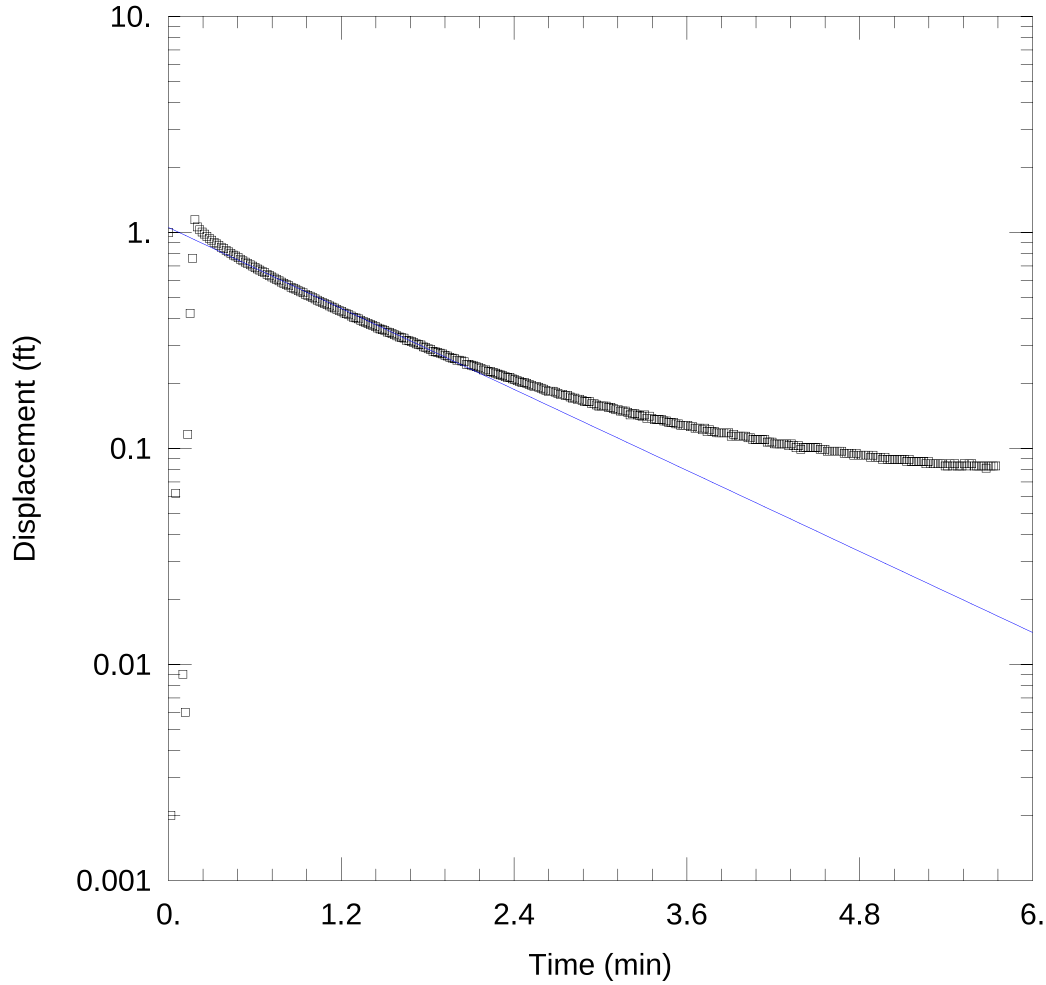
WELL DATA (DMMW0002)

Initial Displacement: 1. ft Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 0.7947 ft/day y0 = 1.031 ft



DMMW0002-RISING HEAD TRIAL 1

Data Set: L:\...\DMMW2-out1HV.aqt
Date: 09/15/08 Time: 14:03:18

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin Williams
Location: Gibbsboro
Test Well: DMMW002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

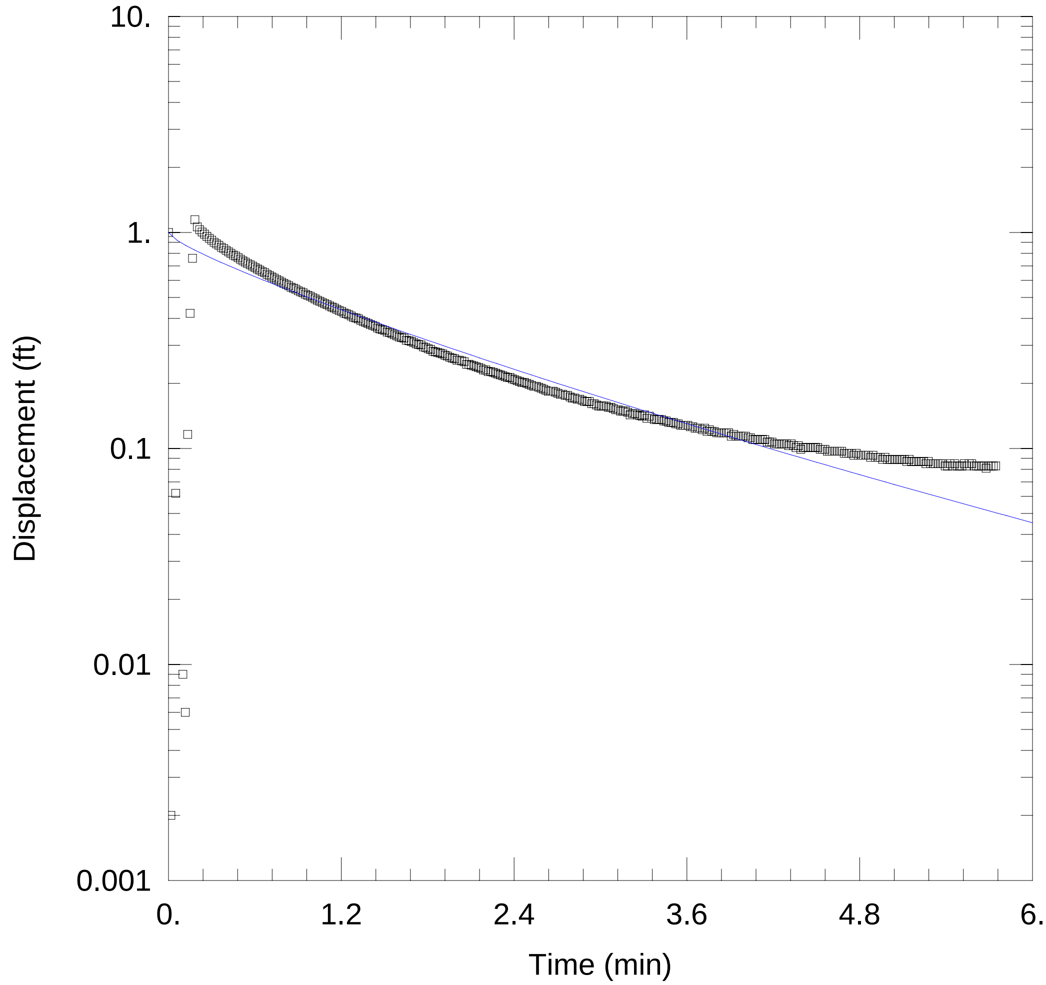
WELL DATA (DMMW0002)

Initial Displacement: 1. ft
Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft
Screen Length: 10. ft
Casing Radius: 0.08 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 1.098 ft/day
y0 = 1.054 ft



DMMW0002-RISING HEAD TRIAL 1

Data Set: L:\...\DMMW2-out1KGS.aqt
Date: 09/15/08 Time: 14:03:49

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin Williams
Location: Gibbsboro
Test Well: DMMW002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMMW0002)

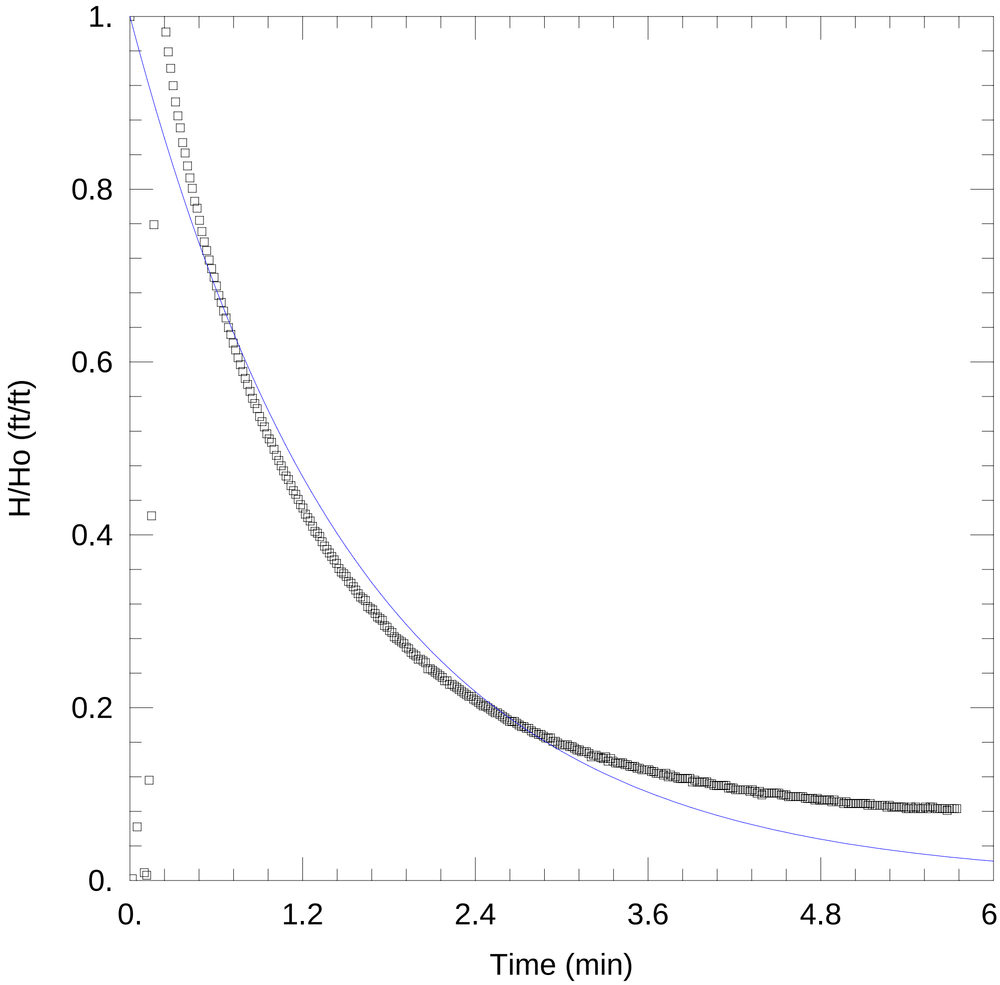
Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft

Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.7029 ft/day
Kz/Kr = 1.
Ss = 4.353E-5 ft^{-1}



DMMW0002-RISING HEAD TRIAL 1

Data Set: L:\...\DMMW2-out1SG.aqt
Date: 09/15/08 Time: 14:04:20

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin Williams
Location: Gibbsboro
Test Well: DMMW002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

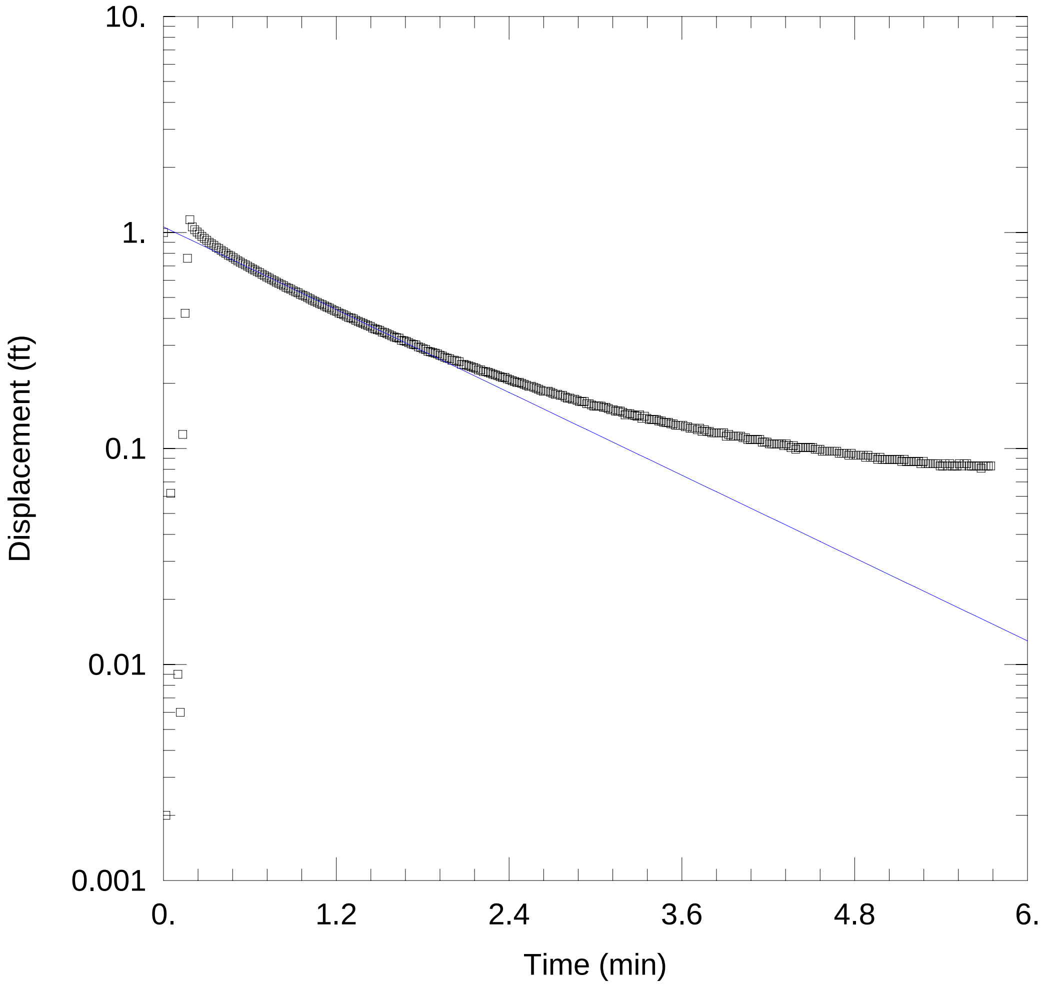
WELL DATA (DMMW0002)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 0.6273 ft/day Le = 0.1 ft



DMMW0002 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW2-out2BR.aqt
Date: 10/28/08 Time: 12:59:59

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

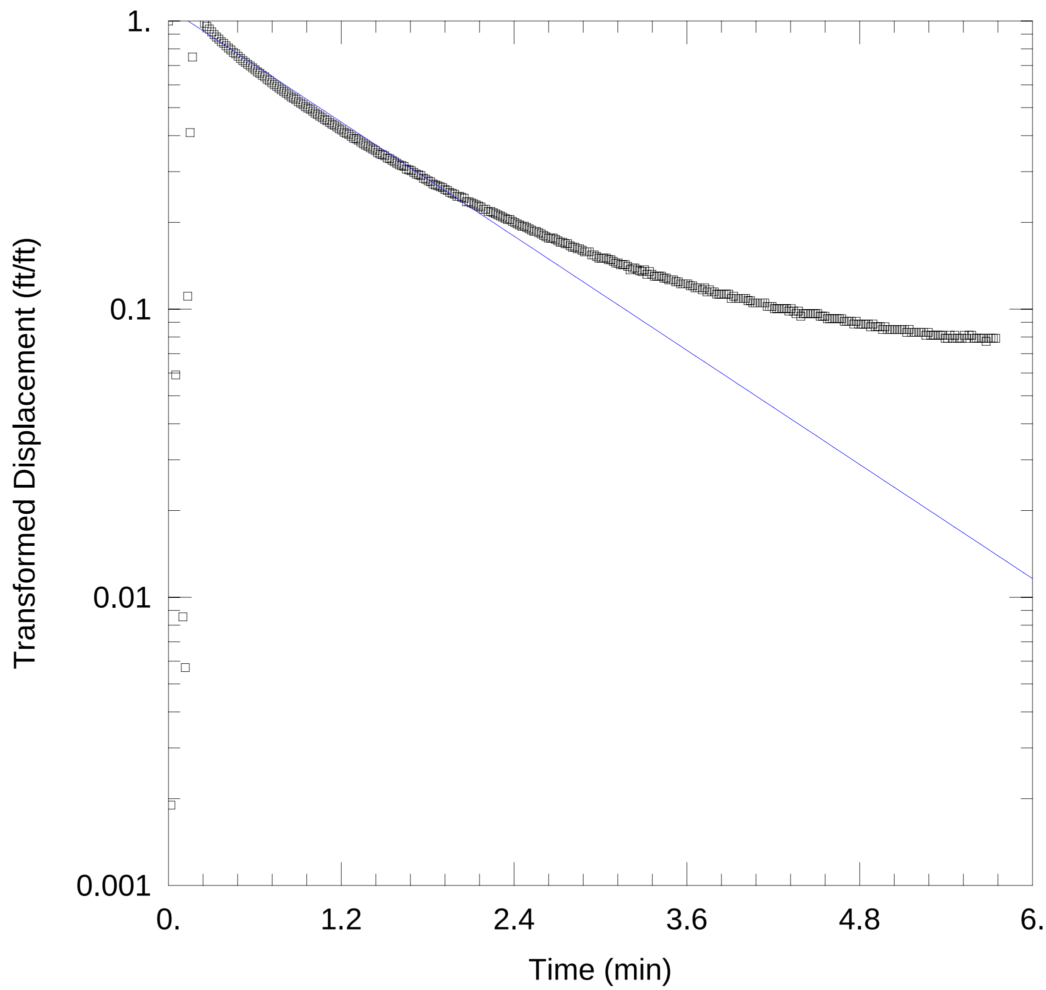
WELL DATA (DMMW2)

Initial Displacement: 1. ft Static Water Column Height: 10.89 ft
Total Well Penetration Depth: 10.89 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.7278 ft/day y0 = 1.061 ft



DMMW0002 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW2-out2DGN.aqt
Date: 09/15/08 Time: 14:05:10

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

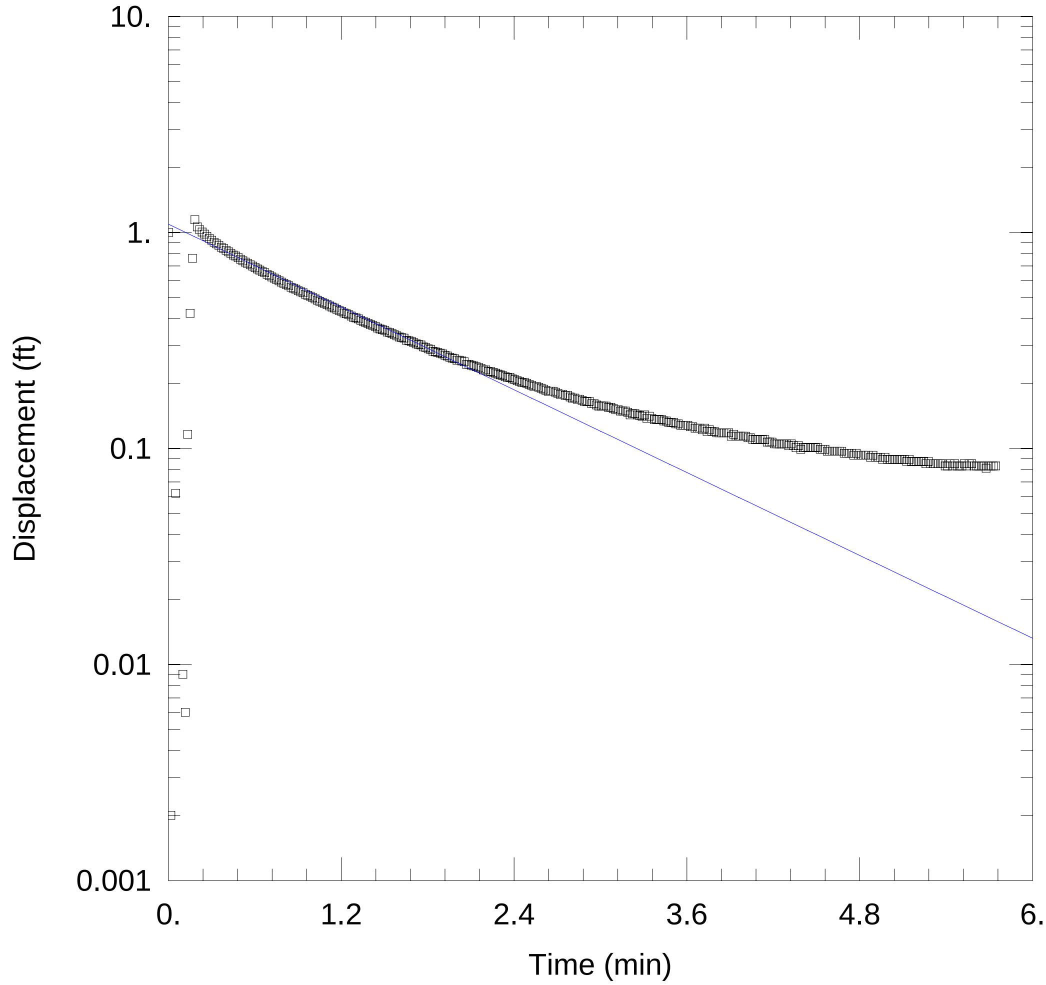
WELL DATA (DMMW2)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 0.8815 ft/day y0 = 1.103 ft



DMMW0002 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW2-out2HV.aqt
Date: 09/15/08 Time: 14:05:42

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

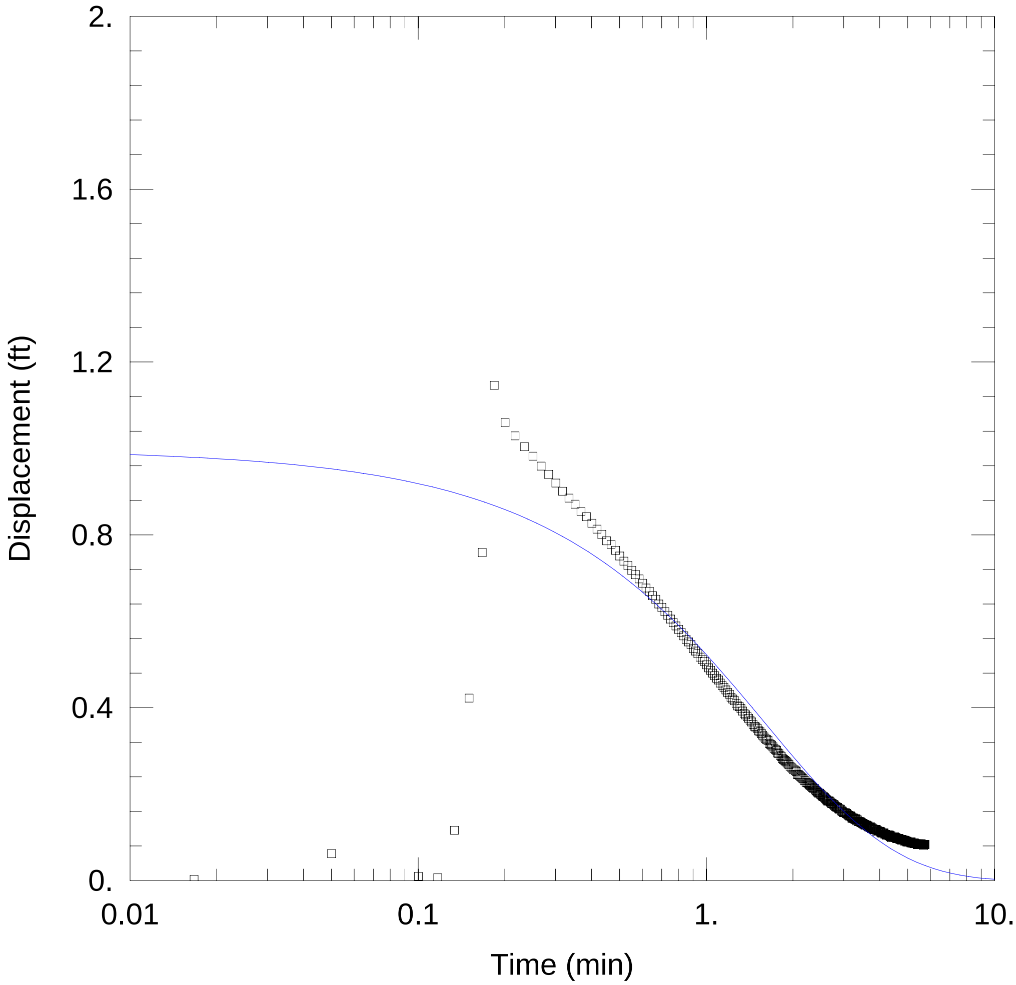
WELL DATA (DMMW2)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.122 ft/day y0 = 1.092 ft



DMMW0002 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW2-out2KGS.aqt
Date: 09/15/08 Time: 14:06:02

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft

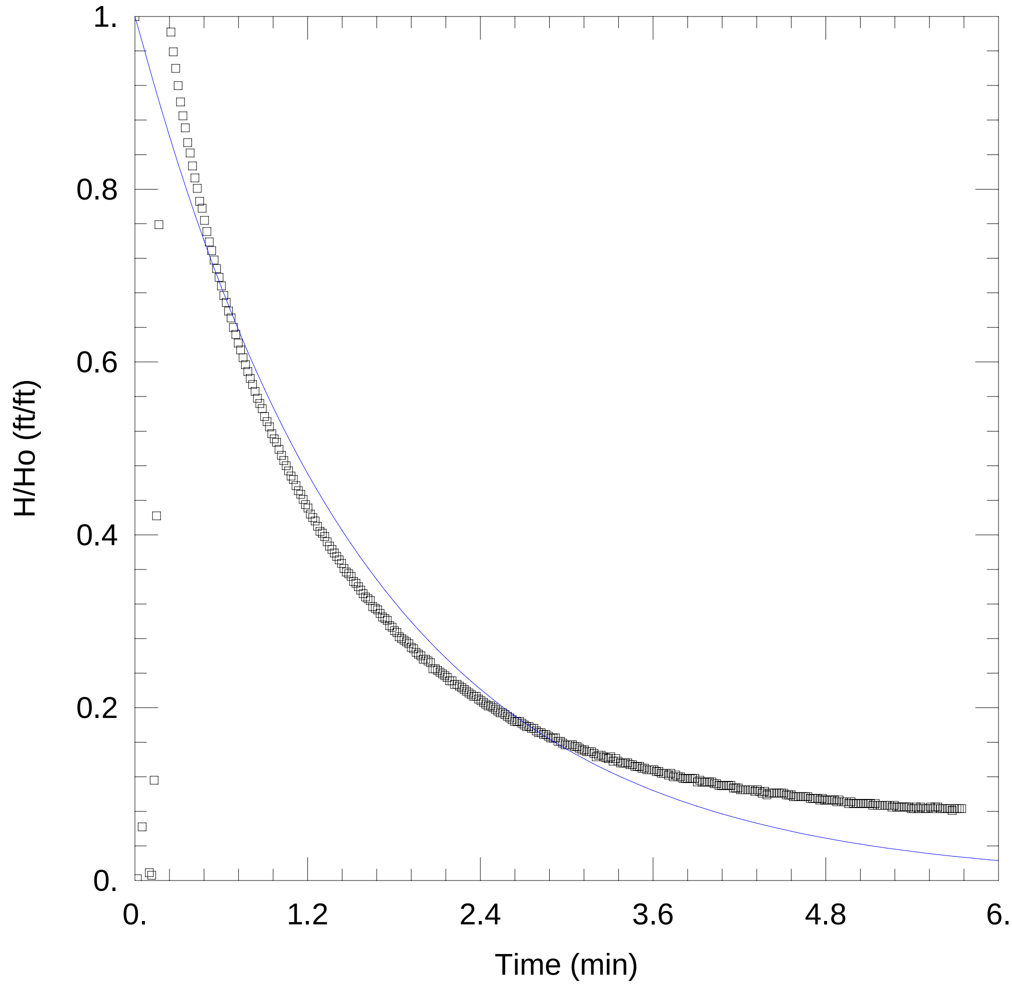
WELL DATA (DMMW2)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.7392 ft/day
Kz/Kr = 1.
Ss = 6.816E-6 ft^{-1}



DMMW0002 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW2-out2SG.aqt
Date: 09/15/08 Time: 14:06:19

PROJECT INFORMATION

Company: Weston Solutions, Inc.
Client: Sherwin-Williams
Location: Gibbsboro
Test Well: DMMW0002
Test Date: 9/8/2005

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

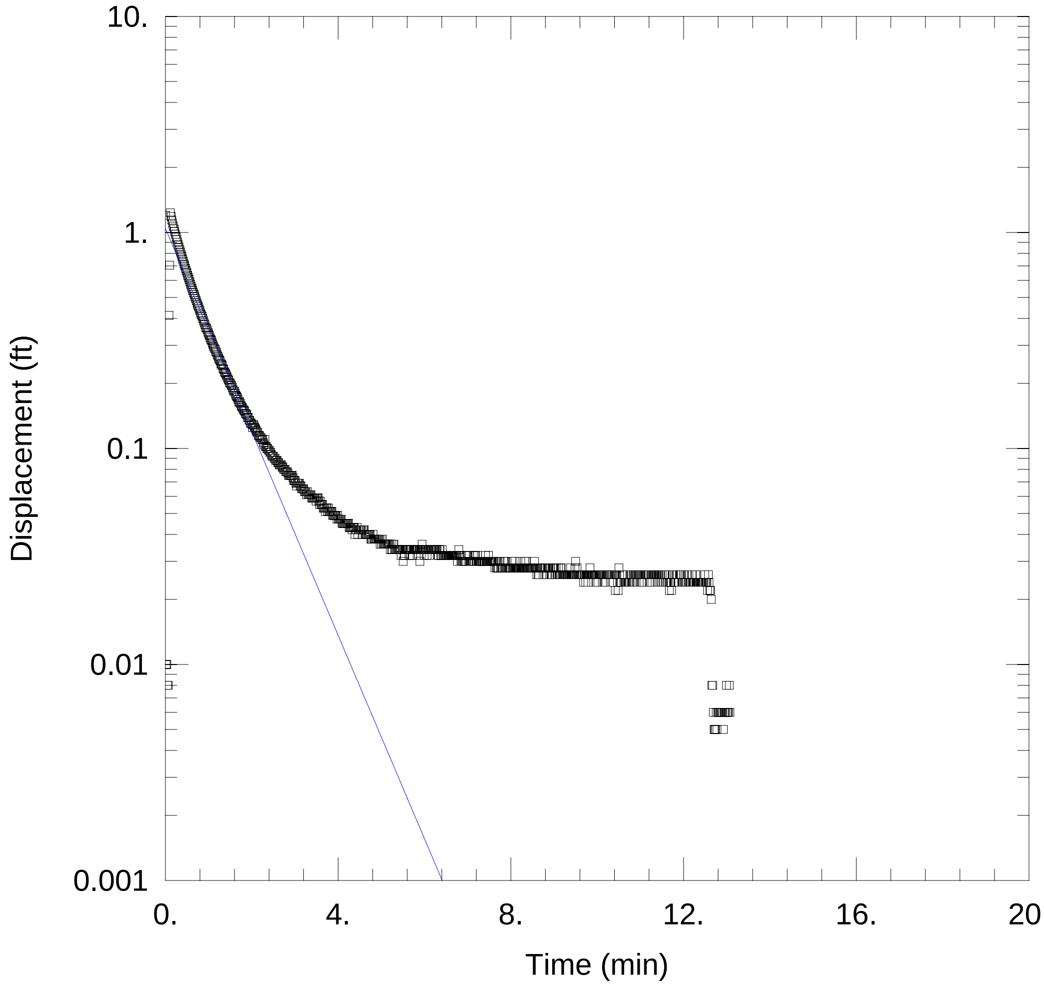
WELL DATA (DMMW2)

Initial Displacement: 1. ft
Total Well Penetration Depth: 10.89 ft
Casing Radius: 0.08 ft
Static Water Column Height: 10.89 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Springer-Gelhar

K = 0.6215 ft/day Le = 510. ft



DMMW0003 - RISING HEAD TRIAL 1

Data Set: L:\...\DMMW3-out1BR.aqt
Date: 10/28/08
Time: 13:01:58

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

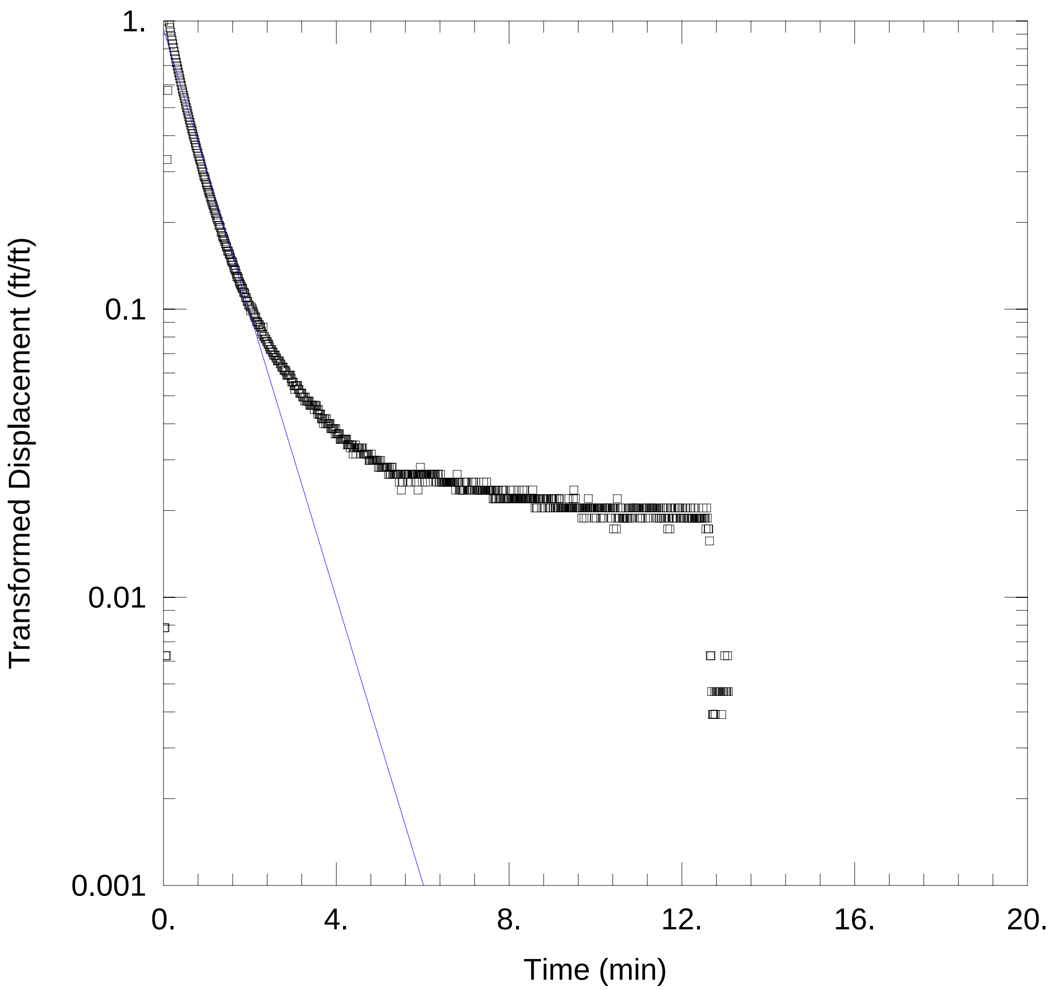
WELL DATA (DMMW3)

Initial Displacement: 1.2 ft
Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft
Screen Length: 10. ft
Casing Radius: 0.08 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.104 ft/day
y0 = 1.044 ft



DMMW0003 - RISING HEAD TRIAL 1

Data Set: L:\...\DMMW3-out1DGN.aqt
Date: 09/15/08 Time: 14:07:07

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

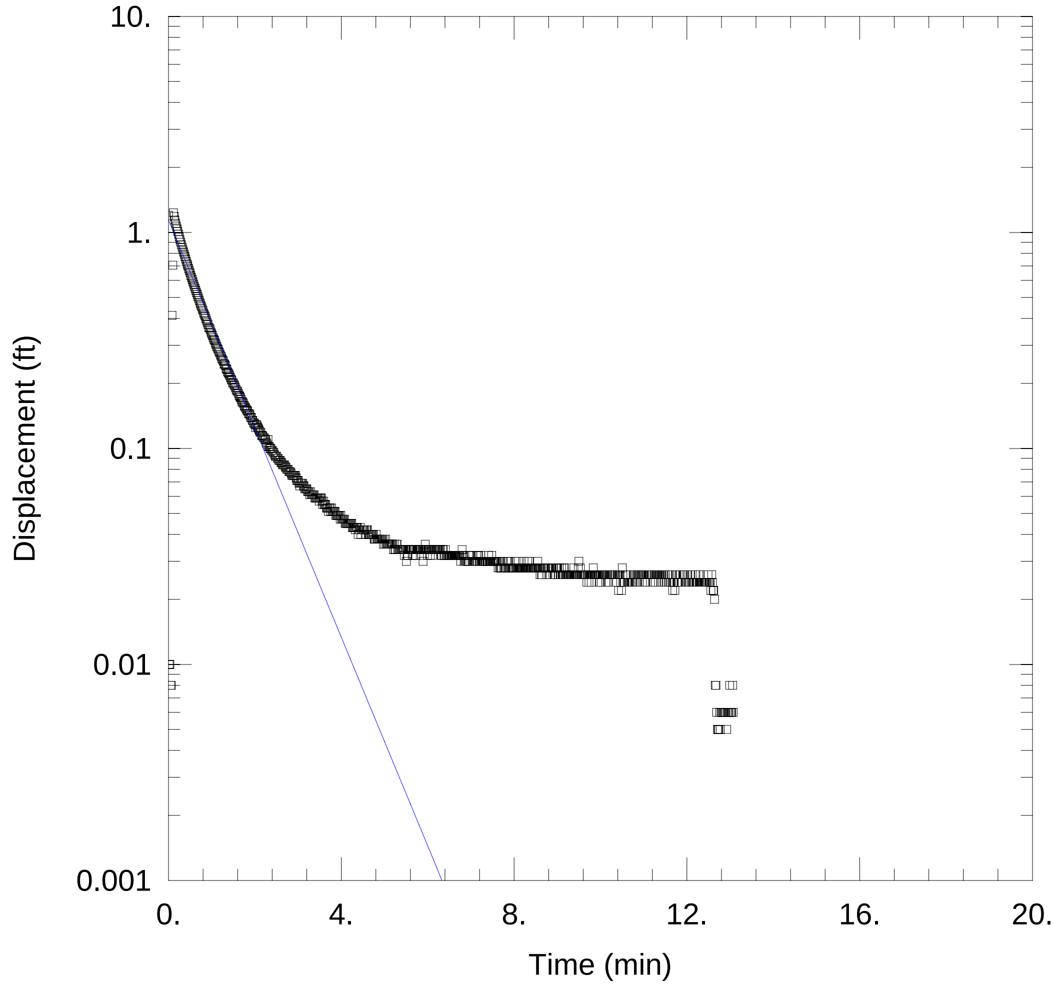
WELL DATA (DMMW3)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 12.39 ft
Casing Radius: 0.08 ft
Static Water Column Height: 12.39 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 1.319 ft/day y0 = 1.128 ft



DMMW0003 - RISING HEAD TRIAL 1

Data Set: L:\...\DMMW3-out1HV.aqt
Date: 09/15/08
Time: 14:07:49

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

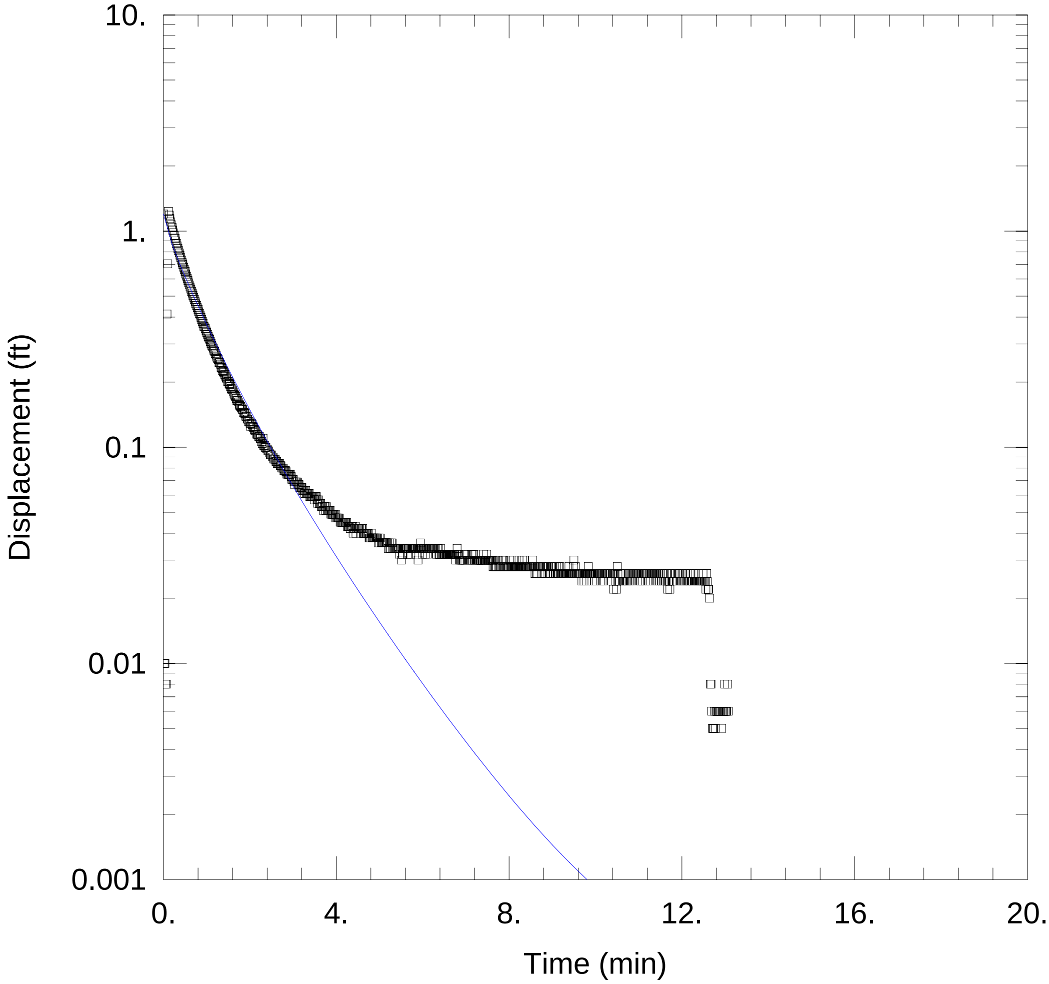
WELL DATA (DMMW3)

Initial Displacement: 1.2 ft
Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft
Screen Length: 10. ft
Casing Radius: 0.08 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 1.697 ft/day
y0 = 1.142 ft



DMMW0003 - RISING HEAD TRIAL 1

Data Set: L:\...\DMMW3-out1KGS.aqt
Date: 09/15/08 Time: 14:08:26

AQUIFER DATA

Saturated Thickness: 30. ft

WELL DATA (DMMW3)

Initial Displacement: 1.2 ft
Total Well Penetration Depth: 12.39 ft
Casing Radius: 0.08 ft

Static Water Column Height: 12.39 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

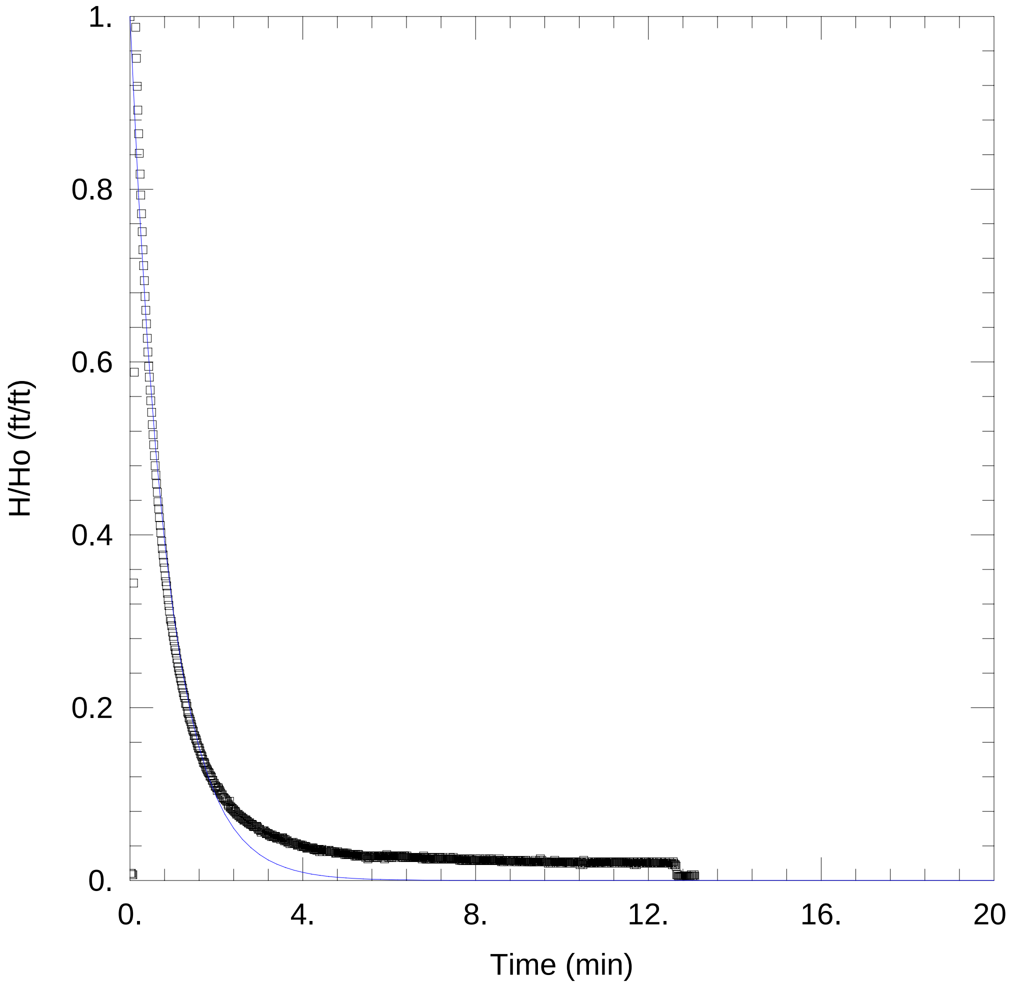
SOLUTION

Aquifer Model: Unconfined

Solution Method: KGS Model

Kr = 1.363 ft/day
Kz/Kr = 1.

Ss = 3.662E-5 ft^{-1}



DMMW0003 - RISING HEAD TRIAL 1

Data Set: L:\...\DMMW3-out1SG.aqt
Date: 09/15/08 | Time: 14:08:49

AQUIFER DATA

Saturated Thickness: 30. ft | Anisotropy Ratio (Kz/Kr): 1.

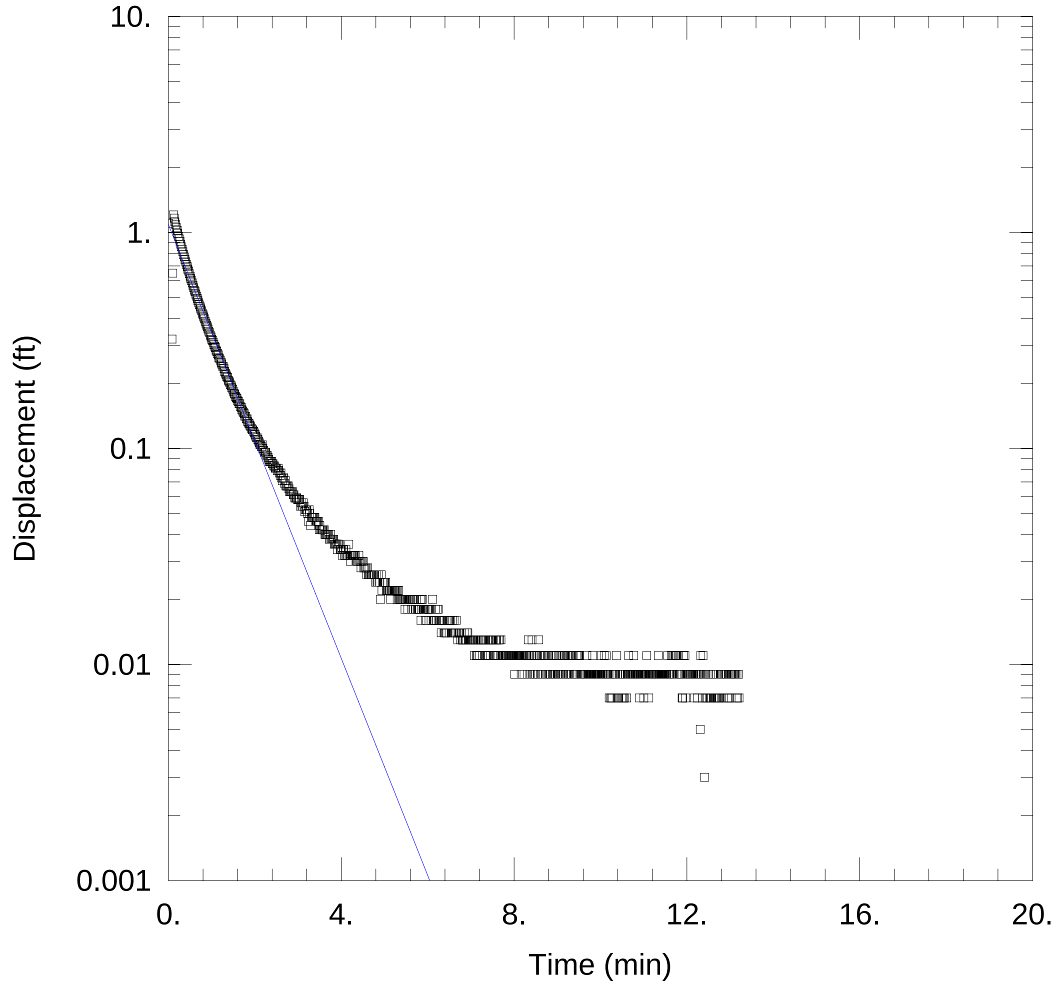
WELL DATA (DMMW3)

Initial Displacement: 1.2 ft | Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft | Screen Length: 10. ft
Casing Radius: 0.08 ft | Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined | Solution Method: Springer-Gelhar

K = 1.191 ft/day | Le = 0.1 ft



DMMW0003 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW3-out2BR.aqt
Date: 10/28/08 Time: 13:03:36

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

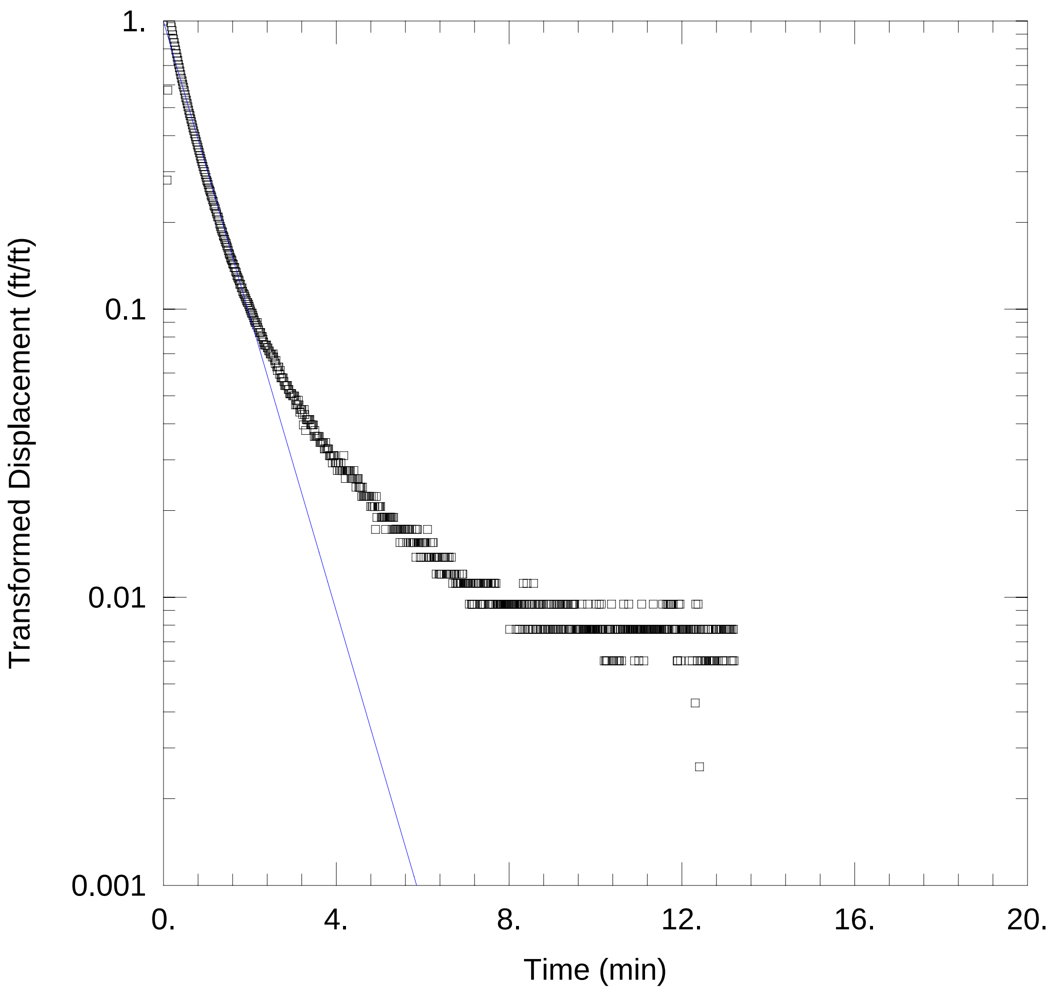
WELL DATA (DMMW3)

Initial Displacement: 1.1 ft
Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft
Screen Length: 10. ft
Casing Radius: 0.08 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.177 ft/day
y0 = 1.086 ft



DMMW0003 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW3-out2DGN.aqt
Date: 09/15/08 Time: 14:10:21

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

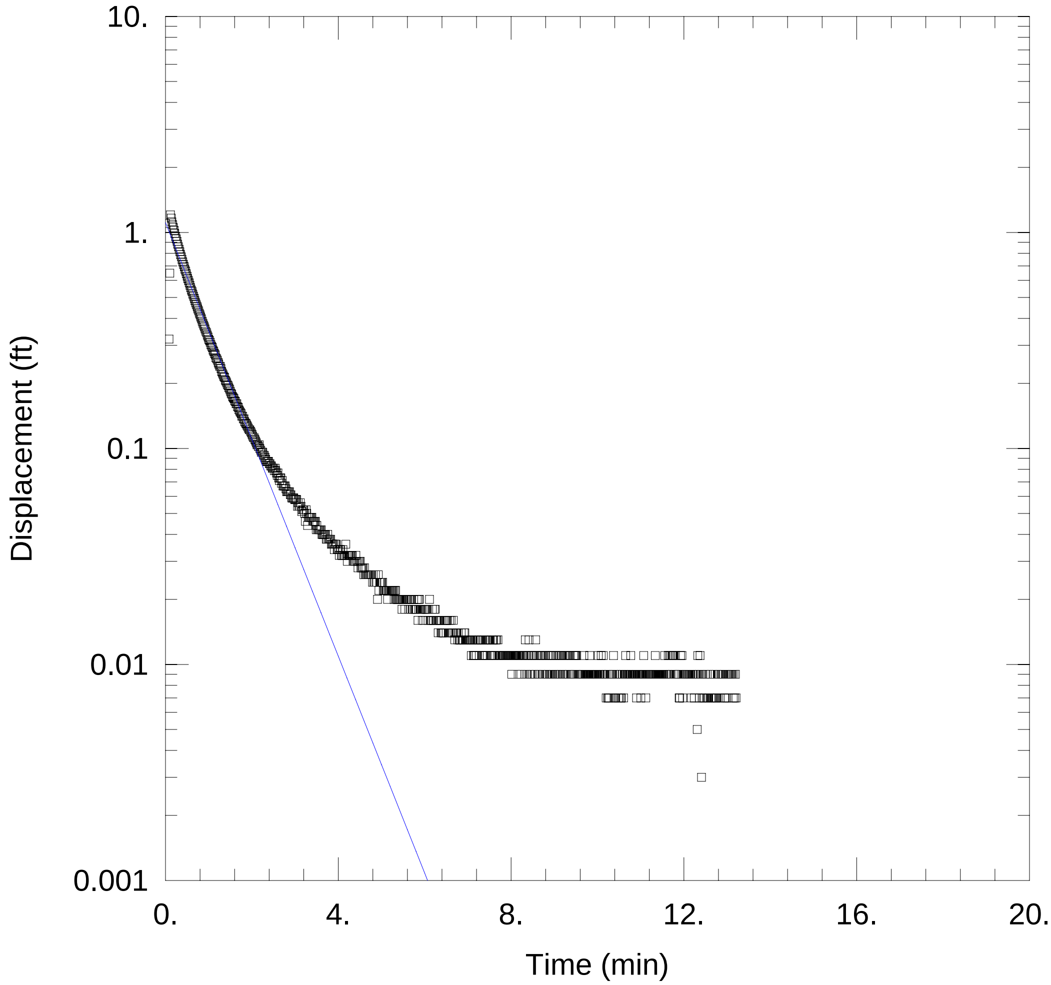
WELL DATA (DMMW3)

Initial Displacement: 1.1 ft Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Dagan

K = 1.367 ft/day y0 = 1.095 ft



DMMW0003 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW3-out2HV.aqt
Date: 09/15/08 Time: 14:11:01

AQUIFER DATA

Saturated Thickness: 30. ft Anisotropy Ratio (Kz/Kr): 1.

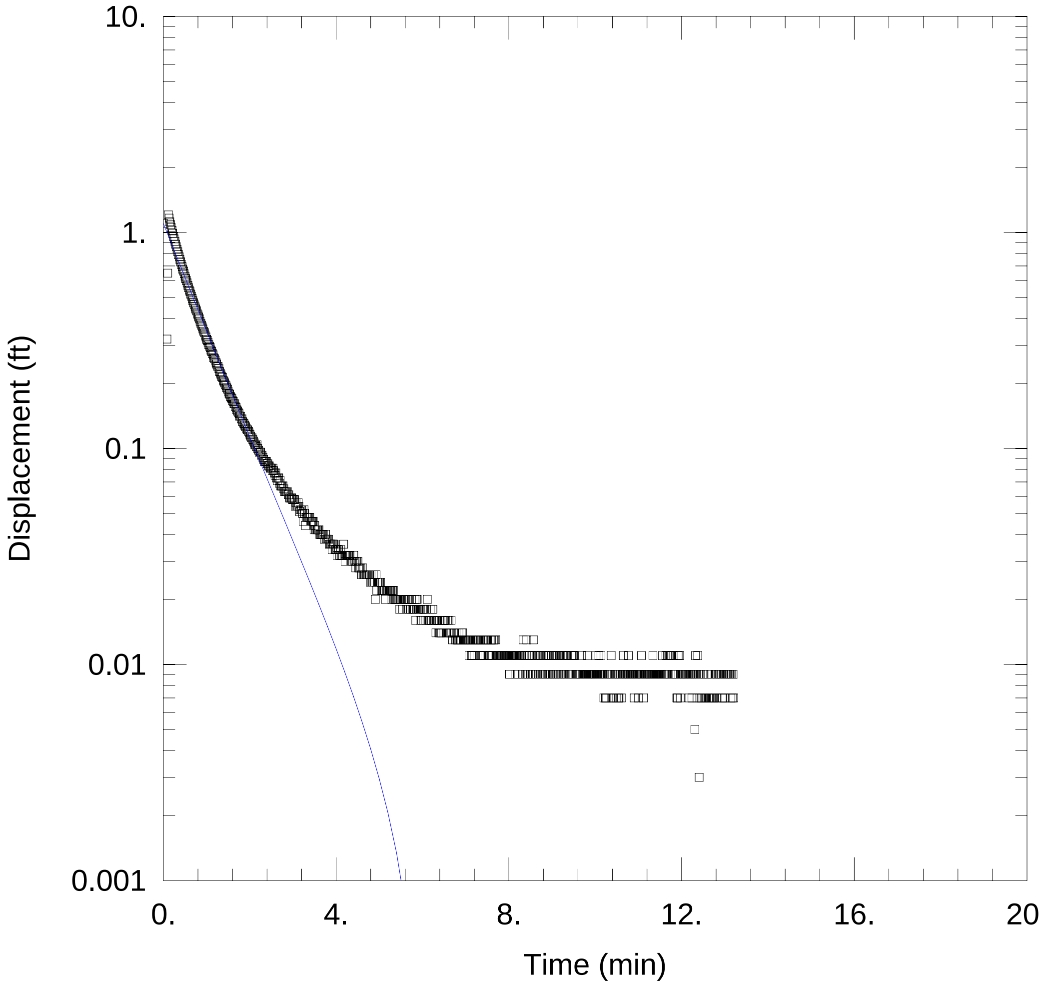
WELL DATA (DMMW3)

Initial Displacement: 1.1 ft Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft Screen Length: 10. ft
Casing Radius: 0.08 ft Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Hvorslev

K = 1.764 ft/day y0 = 1.11 ft



DMMW0003 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW3-out2KGS.aqt
Date: 09/15/08
Time: 14:11:24

AQUIFER DATA

Saturated Thickness: 30. ft

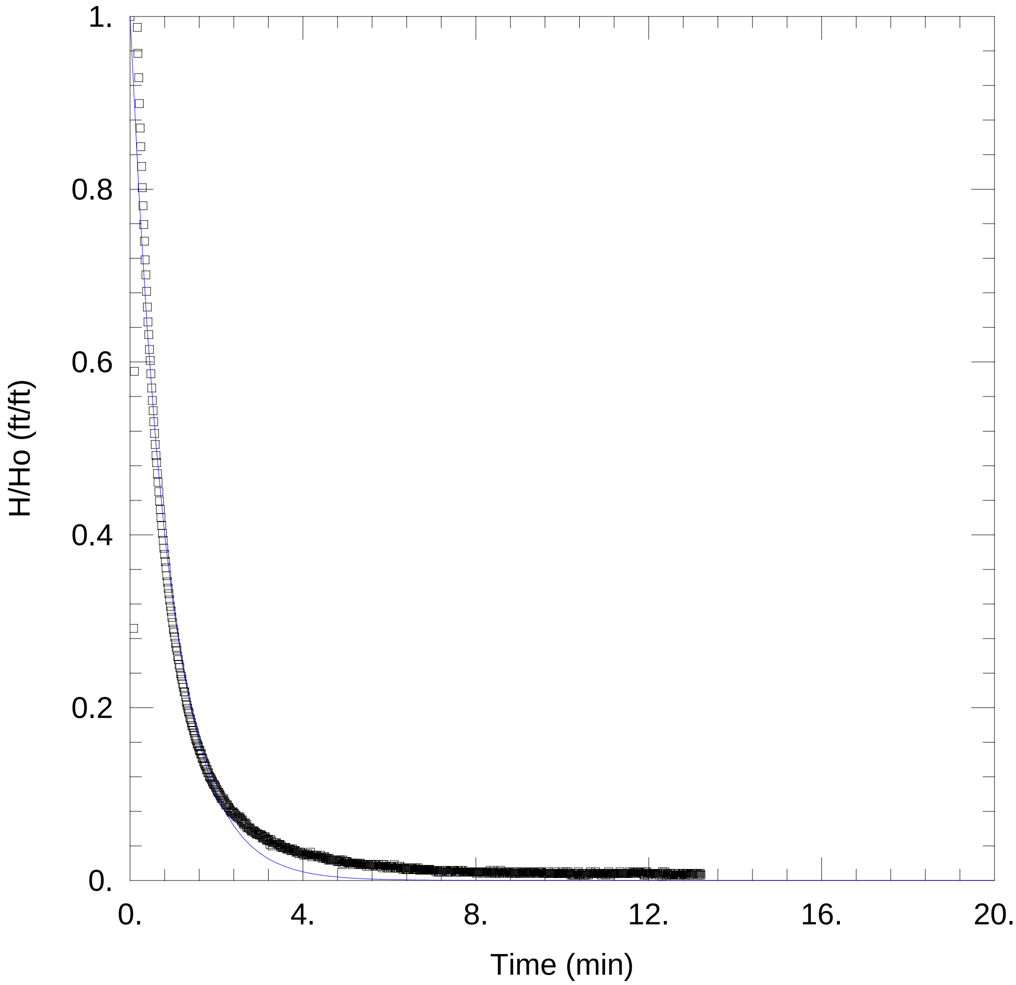
WELL DATA (DMMW3)

Initial Displacement: 1.1 ft
Total Well Penetration Depth: 12.39 ft
Casing Radius: 0.08 ft
Static Water Column Height: 12.39 ft
Screen Length: 10. ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 1.436 ft/day
Kz/Kr = 1.
Ss = 3.333E-12 ft^{-1}



DMMW0003 - RISING HEAD TRIAL 2

Data Set: L:\...\DMMW3-out2SG.aqt
Date: 09/15/08 Time: 14:11:48

AQUIFER DATA

Saturated Thickness: 30. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (DMMW3)

Initial Displacement: 1.1 ft
Static Water Column Height: 12.39 ft
Total Well Penetration Depth: 12.39 ft
Screen Length: 10. ft
Casing Radius: 0.08 ft
Well Radius: 0.365 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 1.166 ft/day
Le = 785.9 ft